THE INTEGRATION OF TECHNOLOGY IN MATHEMATICS AT SECONDARY SCHOOLS IN THE WESTERN CAPE TO ENHANCE LEARNER PERFORMANCE: AN EVALUATION OF THE KHANYA PROJECT

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A minithesis submitted in partial fulfilment of the requirements for the degree of Masters in Information Management in the Department of Economic and Management Sciences, University of the Western Cape.

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AN EVALUATION OF THE KHANYA PROJECT.

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KEYWORDS

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Standard Grade

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Education

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ABSTRACT

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Abstract

There is a dire need to transform Mathematics education in the schooling system in South Africa as this is evident by the poor learner performance in the Mathematics examination results. There is a high failure rate in Mathematics at schools and the number of learners taking Mathematics up to the grade twelve level is on the decline. This study investigates the integration of computer technology in Mathematics education to improve learner performance.

Educationists believe that there is an inherent potential in technology to transform education. However, there is insufficient evidence to support that technology impacts positively on the teaching/learning process. The Western Cape Education Department (WCED) initiated the Khanya intervention project to integrate ICT in Mathematics education at secondary schools in the Western Cape. This large scale project encompasses installing computer labs in schools with the necessary educational software.

A comprehensive Mathematics program called Mastermaths is installed for curriculum delivery in Mathematics lessons. Mastermaths is a multimedia Mathematics programme designed by Mathematics educators in collaboration with software developers. This Learning Management System consists of the matric mathematics syllabus in its entirety, inclusive of Mathematics lessons in modular format, exercises, worksheets and tests. The software and its contents are upgraded from time to time, driven by the updated mathematics syllabus.

A quantitative study was done on the standardised grade twelve examination results before and after the infusion of technology in Mathematics education. The research construct investigated the data at three levels. Statistical analysis was done for all the Grade twelve Mathematics Higher Grade examination results before using technology in education (Pre-IT years) and after using computers in Mathematics (Post-IT years) in three stages. In stage one, a composite analysis was done for all the Higher Grade examination results in the Pre-IT and Post-IT years. In stage two, schools were grouped into waves, according to the number of years that schools had access to computers for curriculum delivery in Mathematics. In stage three, schools in each wave were further categorised according to the socio-economic background of the communities that the schools were located in. An analysis was then done on the Mathematics Higher Grade examination results in the Pre-IT and the Post-IT years. The same procedure used to analyse the Mathematics Higher Grade examination scores is adhered to in the analysis of the Mathematics Standard Grade examination results for the Pre-IT years and the Post-IT years.

The findings of the study indicate that there was an overall increase in the Mathematics standardised examination results after technology integration but there were also schools that showed no increase and some schools had a decline in examination results. The levels of increase in the Mathematics examination results after using technology varied among schools. The findings correlate with international large scale ICT projects that indicate ICT can at times improve outcomes in Mathematics, although individual effects are often weak and findings are inconsistent (Kulik, 2003).

May 2008

DECLARATION

I, Indren Govender, declare that "The Integration of Technology in Mathematics at Secondary Schools in the Western Cape to enhance Learner performance: An evaluation of the Khanya Project" is my own work, that it has not been submitted before for any degree or examination in any other university, and that all the sources I have used or quoted have been indicated and acknowledged by complete references.

Indren Govender May 2008

Signed:…………………….

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Chapter One

1. Introduction

1.1 Background

In 2001, the minister of education in the Western Cape stated "Research and learner results, particularly in our poorest schools, indicate that prospects for Mathematics in South Africa are dire" (Zille, 2001). The concern about the state of Mathematics performance at schools is well documented. A survey conducted by the International Association for Educational Achievement to assess Mathematics performance at schools in 41 countries produced results that were indicative of South Africa's mean score of 275, which was well below the international mean of 487 (HSRC, 2005). An average of 11% of the total complement of grade 12 learners register and pass Mathematics on the Higher Grade (Smith, 2005).

The Western Cape Education Department (WCED) investigated various initiatives to improve Mathematics performance, particularly in schools serving poor communities. In April 2001, the Khanya Technology in Education Project was initiated by the WCED and was referred to as the Khanya Project. This project explored the utilisation of information and communications technology (ICT) for curriculum delivery, especially in Mathematics education. Computer labs, comprising of 25 networked computers with the necessary hardware, software and internet connection were installed in schools that served learners from a disadvantaged background.

A comprehensive Mathematics program called Mastermaths was installed for the teaching/learning of the subject. Mastermaths is a multimedia Mathematics programme designed by Mathematics educators in collaboration with software developers. This Learning Management System consists of the matric mathematics syllabus in its entirety, inclusive of Mathematics lessons in modular format, exercises, worksheets and tests. The software and its contents are upgraded from time to time, driven by the updated mathematics syllabus.

From the period 2002 to 2005, the Khanya intervention project has installed computer labs in 845 schools and aims to successfully complete implementing computer technology in all schools in the Western Cape by 2012. The primary objective of the Khanya Project, shifting from a broad perspective to specifics, is "to create a technology rich province thereby narrowing the digital divide and harnessing the power of technology to deliver curriculum in order to improve the quantity and quality of learner results, especially in Mathematics" (Khanya, 2002).

1.2 Value of Research

A hundred million rand project of such a large scale needs to be evaluated to assess the value or return on investment. The Khanya management team has expressed interest in the results of this study that can be used in the further development and progress of the project. In addition, other provinces in the country consider the Khanya Project as a model for technology integration in education, with the project being the recipient of various awards for its achievement. An assessment will be informative to guide policy and practice in Mathematics education as well as in the other subject areas that intend infusing Information and Communications Technology-mediated learning for curriculum delivery. The South African government strategy document on ICT in education reports that "the South African government is seeking a co-ordinated interdepartmental approach to generating ICT-enabled learning." (HSRC, 2005).

1.3 Aims and Objectives

The research topic is: "The integration of technology in secondary school education to enhance learner performance in Mathematics". The key objective of the Khanya Projects is to implement technology in schools for curriculum delivery in Mathematics education in at attempt to improve learner performance. The key research question of this study: Does ICT integration in Mathematics education impact on learner attainment? The researcher seeks to statistically analyse examination scores of learners before using computers in Mathematics education and after technology integration, in an attempt to determine the effect of technology on levels of achievement in Mathematics. This research study attempts to determine the successful integration of ICT in Mathematics education on the basis of results or evidence emerging from the statistically analysed standardised examination scores of the Pre-IT and Post-IT phases.

1.4 Research Hypotheses

A hypothesis is a hunch, an educated guess that is advanced for the purpose of being tested (Neuman, 2000). Mouton (1996) states that when we first formulate a statement without knowing whether we have any empirical warrant to accept it as reasonably valid or even true, we call this a hypothesis. A good hypothesis is empirically testable, which means that we must be able to specify clearly what data would provide support or rejection for it (Mouton, 1996). The research hypothesis to be tested is: Computer integration in Mathematics education for curriculum delivery enhances learner performance.

There are various ICT integration projects in schools in developed countries such as the United States of America (USA), United Kingdom (UK) and Australia. The researcher will conduct a comprehensive study of large scale ICT implementation projects in countries that have explored using technology in education; relating to the Khanya Project. A lack of large scale ICT projects in developing countries limited the literature survey of this study to ICT projects in developed countries. This study will attempt to establish the ICT integration strategy and the assessment of the technology infused projects, including the pedagogical aspect of constructivist learning paradigm. An empirical study will be conducted to investigate the effect of technology integration in Mathematics education. The quantitative methodology will be used in an attempt to determine the effect of computer aided instruction on learner attainment.

1.5 Plan of Development

This research report comprises of the following five chapters that comply with the research process:

Chapter One

The introduction describes the background of the research and the motivation for the research problem. The aims, objectives and research hypotheses are also highlighted.

Chapter Two

The literature review explores ICT implementation in developed countries over a period of time and ICT projects in South Africa. A study is made of the ICT strategy, the process of integration and the outcomes thereof. The pedagogical transformation as a result of technology infusion in education is explored. The Khanya Project which forms an integral component of this research will be introduced.

Chapter Three

The research design and methodology discusses the research plan, methodologies and instruments used to collect and collate the data for statistical analysis. Limitations or gaps in the research design are discussed. The unfolding of the three levels of the research design is explored.

Chapter Four

The findings of the study are discussed and interpreted, including positive and negative findings in the context of the hypothesis.

Chapter Five

The conclusions and recommendations include a summary of the findings with the literature reviewed. Aspects that need further research and the implications of this study are highlighted.

Chapter Two

2. Literature Review

2.1 Introduction

"Rarely in the history of education has so much been spent by so many" (Coleridge, 2003). Governments and the private sector of developed countries have invested enormous sums of money to install ICT projects in schooling systems. This report explores the effect of these large scale ICT projects on learner performance, especially in the field of Mathematics. The effective use of ICTs in education refers to the positive contribution ICTs make towards the process of teaching and learning (Patrick, 2000). It encompasses improving the quality and outcomes of teaching and learning. There is a need to understand how learning is advanced through the use of ICT in education, in such a way as to propose that the implementation of technology will help to solve a particular set of problems, thus implying a return on investment (Bergh, 2002).

Globally, most of the major ICT implementation programmes have occurred in developed and economically rich countries in Europe and the United States of America. This literature review evaluates the impact of technology on education in these countries with the emphasis on Mathematics education. There is a lack of large scale ICT studies in developing countries. The organisation, Trends in International Mathematics and Science Study (TIMSS) collects educational achievement data in Mathematics and Science globally, analyses the data and provides information about trends in performance over a period of time. According to TIMSS, difficulties in Mathematics learning as well as the low results that students often obtain in this field are frequently reported (TIMSS, 2003). For teachers too, Mathematics is traditionally a sector where they experience major problems in finding appropriate pedagogical approaches suited to overcome the difficulties encountered by a considerable number of learners (Bottino, 2004). In addition, enrolment for Mathematics is essential together with a favourable pass for learners to study in the field of science and engineering at university level. The report also examines the pedagogical dimension of teaching and learning with ICT. The Khanya Project is contextualized in relation to the literature reviewed, which provides the basis for the development of the research design.

2.2 Literature Survey of ICT Projects in Education

2.2.1 OECD Countries

The Organisation for Economic Co-operation and Development (OECD) is based in Europe and comprises of thirty member countries. The OECD is best known for its research and publications in the field of economic and social issues; from macroeconomics to science innovation and education. The Centre for Education Research and Innovation (CERI) is a major division of the OECD Directorate for Education. CERI is responsible for education research and analysis in European countries and countries outside Europe that subscribe to the OECD. It disseminates its work to a wide range of audience including researchers, policy-makers and practitioners.

Over the last decade, the governments of OECD countries have invested heavily in ICT in their respective schooling systems. Technology is deployed for a range of purposes encompassing improving school information systems, teaching ICT skills and improving teaching and learning. The cost of implementing technology of such a scale across all OECD countries is estimated at sixteen billion dollars (OECD, 1999). The key principle for implementing ICT in schools is that there is a belief that ICT offers a powerful tool to improve the outcomes of education: to improve the quality of teaching and also the quality of students' learning (OECD, 2001).

Results of studies conducted by OECD indicate that having computers in schools is one thing but using them is another (OECD, 2004). Table 2.1 reflects the different patterns of computer use existing in countries with the same ratio of learners per computer. Even in countries with the highest levels of investment in ICT, computers do not seem to be used most of the time. Denmark and Japan both have five learners per computer (Table 2.1). However, in Denmark 23% of learners use a computer almost every day, 45% few times in a week, but only 2% of learners in Japan use computers almost everyday. Differences are also noted between Korea and the United Kingdom. The table also shows that only in a handful of countries do computers appear to be used regularly at schools. From these patterns it can be deduced that an under-utilisation of investment in ICT exist in schools in certain countries.

Table 2.1 Learners per computer and frequency of use of computers at school

		Learners using computers at high school %				
Country	Number of Learners per computer	Almost everyday	Few times a week	Between once a week and once a month	Less than once a month	Never
United States	3	20	23	28	21	8
Australia	4	15	44	27	11	3
Hungary	4	6	74	10	4	5
Korea	4	4	25	29	14	28
New Zealand	4	21	22	26	23	8
United Kingdom	4	23	48	13	10	5
Austria	5	11	42	31	9	7
Canada	5	15	26	31	21	8
Denmark	5	23	45	25	6	1
Japan	5	2	24	33	16	25
Finland	6	4	32	41	18	5
Iceland	6	5	36	40	13	6
Sweden	6	15	33	30	15	6
Switzerland	6	3	27	36	21	13
Belgium	7	2	25	35	19	20
Italy	8	4	47	20	11	18
Czech Republic	9	5	36	44	7	8
Ireland	9	2	22	27	16	32
Germany	12	1	22	28	27	21
Greece	12	4	41	27	9	19
Mexico	12	8	46	16	10	20
Portugal	14	5	29	25	26	15
Poland	15	2	42	34	10	12
Slovak Republic	15	4	38	30	7	21
Turkey	25	7	39	8	6	40

Source OECD : PISA Database

In the OECD countries, limited experimental studies are conducted, providing insufficient evidence on the impact of technology upon learning outcomes. This is due to two main reasons (OECD, 2004): It is difficult for such evidence to pick up the wider learning outcomes that ICT might be expected to improve, and secondly, it is a challenge for results to keep up to date with the rapidly evolving potential of technology. Within these constraints, synthesis of existing research provides some qualified support for proponents of the use of technology to improve learning. (Kulik, 2003) stated that ICT can at times improve outcomes in Mathematics, although individual effects are often weak and findings are inconsistent.

CERI identified various barriers to ICT improving the quality of teaching and learning at schools. Limited resources is one of the factors that affect the educational use of ICT in most OECD countries as well as the inadequate use of the available technology at schools. One of the key findings in the survey done on principals, highlighted three obstacles in schools reaching their ICT developmental goals, each of which affected 60 % or more of all learners across the OECD schools. These are (OECD, 2004):

- Difficulty in integrating computers into classroom instruction.
- Teachers lack of knowledge in using computers as a teaching tool.
- Teachers not having enough time to prepare lessons that use computers.

It was evident from the findings that, besides upgrading educators' computer skills, the development of pedagogical skills was equally relevant to adapt to the new teaching tool: ICT.

The findings from case studies (Richard, 2002) reflect that the staff of the school must buy into the ICT policy since they are the key role players in integrating ICT into the curriculum. Therefore, it is important to understand how innovations in education come to be adopted or rejected by educators. Research on this topic has been conducted by Rogers, (1995) who has contributed a widely accepted conceptual framework for the issue. The starting point is to view schools as social systems composed of individuals with varying degrees of openness to technological innovations. The rate at which an innovation is adopted within the school is a function of certain characteristics of the organization staff, the innovation and the information disseminated about it. An innovation will be adopted more swiftly if the innovation is compatible with the adopters' current practices and values. Rogers (1995) divides potential adopters into five categories, based upon socio-economic status, communication behaviours and personality values:

- innovators
- early adopters
- early Majority
- late Majority
- laggards.

Change agents can affect adoption decisions positively by providing knowledge and training and reassuring potential adopters that an innovation will meet their needs. Sufficient professional development opportunities and support, compensated time off for training and an adequate ICT infrastructure present the optimal conditions for advancing the adoption of technology by a school staff. Diffusion of ICT in schools can stall or retreat without appropriate leadership or the aspects just described (Rogers, 1995).

Both infrastructural and educator competencies are required for the successful implementation of technology in schools. During the initial stages of implementing technology in schools, a reliable and user-friendly infrastructure is critical. As educators become more technically competent, their general pedagogical abilities and their ability to integrate ICT into the curriculum become more significant. Educators need time and support to experiment with integrating technology in their teaching. The most successful staff development programmes teach both ICT skills and related pedagogical skills, including how to integrate ICT in teaching. Richard (2002), states that several reports claim that standards in education are higher due to ICT access, but one study reported lower standards and another cautioned that teaching ICT skills in content area lessons took time from regular subject matter and therefore resulted in less content being covered.

2.2.2 United Kingdom

In 1998, the British government initiated a large scale "ICT in School Programme". The British Educational Communications and Technology Agency (BECTA) was commissioned to manage this ICT project that deployed technology in schools in the United Kingdom (UK) and conduct research on the impact of ICT in education. As government's partner in the strategic development and delivery of its e-strategy, BECTA had three key goals:

- To advise government on the contribution that technology can make to education.
- To develop and implement ICT in schools across the UK and establish effective programme management.
- To provide insight through analysis and research.

BECTA consulted academics from universities in the UK to conduct research on ICT in education in order to fulfil its goal of collating, analyzing and interpreting research evidence relative to technology in education. The evidence from the research (Becta, 2003) shows the positive effects of specific uses of ICT on pupils' attainment in almost all of the national curriculum subjects. The most substantial evidence was in English, Science and Mathematics. It is evident that there is a strong relationship between the ways in which ICT is used and pupils' attainment (Becta, 2003). This suggests that the pedagogical approach is a crucial component to successfully infuse ICT in education.

Two major UK studies conducted by BECTA investigated the effects of ICT on pupils' attainment in Mathematics. The first study developed a range of assessment methods based on those used by previous large scale projects, including new methods designed to measure attainment in conceptual understanding and intellectual processes. The findings (Becta, 2003) showed that learners who used subject-based Mathematics software achieved statistically higher scores in tests than those learners who were taught similar concepts through traditional methods. The results provided significant evidence of a positive impact of ICT on pupils' learning in Mathematics, in classes where ICT is integrated into the Mathematics curriculum. Mini-studies that were conducted, provided additional evidence of the positive effect of ICT on attainment in mathematical reasoning using a programming language called Logo and in Boolean logic skills using databases (Becta, 2003).

The second major study reported additional evidence that technology had a positive relationship to pupils' learning of mathematical skills (Harrison, 2002), and the learners' results varied in relation to the amount of time learners spent using technology in Mathematics lessons. It was evident (Becta, 2003) that those learners who used the tools of ICT in Mathematics lessons more frequently, outperformed the lower end users of ICT in Mathematics. An analysis carried out by BECTA found that improved results are output across the curriculum in schools that make more use of ICT. The findings reflect that schools that are well resourced in ICT, manage their technology efficiently, practice sound ICT teaching and learning and make good use of the resources achieved higher results compared to schools where these aspects were lacking (Becta, 2003).

2.2.3 United States of America

According to the International Data Corporation, the United States of America is ranked number one as the nation most prepared for the information age (Howell & Lundall, 2000). The USA has the greatest levels of connectivity of all countries and the highest levels of internet use. By 1999 (US Dept. of Ed, 2003), the majority of the schools had computers and more than 50% of the computers were multimedia models with sound cards and cd-rom, and in 2002, 98% of American schools had internet access. In the past ten years, forty billion dollars has been spent on upgrading and maintaining the technical infrastructure of America's public schools and on training its teachers to use that technology well (Dickard, 2003). Reports suggest that learners from different socio-economic strata and different racial and ethnic groups have different access to computers. A digital divide separates the information–rich and the information-poor segments of society, but the digital divide is beginning to narrow (Kulik, 2003). Many reports present strong assertions that technology can catalyse changes in the content, methods and overall quality of the teaching and learning process, triggering changes away from the lecture-driven instruction and towards constructivist, inquiry-oriented classrooms (US Dept. of Ed, 2003).

Meta-analytic approaches were used to locate studies and analyse the results. Meta-analytic reviews use objective procedures to locate as many studies of an issue as possible (Kulik, 2003). They describe features and outcomes of the studies using objective and quantitative methods. Finally, meta-analysts use statistical methods to describe overall findings and to chart the relationships between study features and outcomes (Kulik, 2003). Most of the reviews on technology in education use effect size measures to summarize findings. An effect size specifies the number of standard deviation units separating the outcome scores of treatment and control groups in a study. Effect sizes may be positive or negative. It is positive when the treatment group outperforms the control group and it is negative when the control group comes out on top. An effect size of about 0.2 is considered to be small, 0.5 is considered moderate and 0.8 is large in size (Cohen, 1977). When effect sizes in education are above 0.25, results are considered large enough to be educationally meaningful (Slavin, 1990).

Sixteen controlled studies were conducted on the effectiveness of integrated learning systems (ILSs) in Mathematics. Each of the sixteen studies found that Mathematics standardised test scores are at least slightly higher in the group taught with ILS; and the ILS effect in nine of the studies were large enough to be considered both statistically significant and educationally meaningful (Kulik, 2003). The median ILS effect in the sixteen studies was to increase Mathematics test scores by 0.38 standard deviations, or from the 50th to the 65th percentile. Another review of ILS effectiveness reported similar results. Bekker (1992) reviewed thirty two studies of ILS effectiveness. The median effect on Mathematics achievements in these studies was an increase in test scores of 0.40 standard deviations. An effect size of 0.40 is equivalent to an increase in test scores from the 50th to the 66th percentile. Evaluations have found evidence suggesting (Kulik, 2003) that ILS effects would be stronger if learners spent more time on ILS instructions. In typical ILS implementations, students spend only 15% to 30% of the recommended time with these programs.

2.2.4 South Africa

The only large scale ICT project in South African schools that preceded the Khanya Project is the Gauteng Online Project (GoL). This project was initiated in the year 2001 with an amount of R 500 million from the Gauteng government and another four million rands from public-private partnerships to complete and maintain the project. The project involves the provision of an average of 25 networked computers, special devices such as integrated big screen TV sets, a DVD, video recorder and a satellite dish with internet access in each school that would benefit the 500 000 learners in Gauteng Province. Teachers were trained in basic IT skills and how to use the Microsoft office package.

Research that was conducted on the GoL project states that there was very limited use of ICT in the teaching of subject matter. There was no effective plan for integrating ICT in curriculum delivery therefore leveraging ICT in the teaching learning process was not evident. The internet is used for research and the application packages for typing assignments and projects. Teachers provided evidence of the necessity for ICT training to promote professional development in integrating technology into classroom teaching.

2.3 ICT and Pedagogic

The South African national department of education stipulates that participation in the information society means that "Every South African learner will be ICT capable (that is, use ICTs confidently and creatively to help develop the skills and knowledge they need to achieve personal goals and to be full participants in the global community) by 2013", (DOE, 2003). Full participation in the information society is enabled by successful e-education, which, according to the DOE (2003) incorporates learner-centered pedagogy, inquiry-based learning, collaborative work and the development of higher level thinking skills. The adoption and integration of computers is a challenging and complex process for schools, particularly where there is limited previous experience in the use of ICTs to support teaching and learning (Strydom, 2005). More recently, ICT integration is viewed as using computers to learn rather than learning to use computers.

Hokanson & Hooper (2000) state that what is important about computer use is not being able to wordprocess, or view a multimedia presentation, but the ability to interact with the computer in the manipulation and creation of knowledge through the rapid manipulation of various symbol systems. They add that the value of ICT lies in improving the capability to generate thought. This concept of "generative use" underpins the Piagetian cognitive constructivist view of knowledge and learning which assumes that knowledge is not a product that can be transmitted from one person to another, but a process of individually constructing knowledge (Strydom, 2005). Jonassen and Reeves (1996) use the term "cognitive tools" to refer to the role of ICTs in enhancing the learners' cognitive powers during thinking, problem-solving and learning. If teachers' epistemological assumptions are defined by constructivist theories of learning, then they are likely to extend the use of computers to generative uses (Strydom, 2005). This may be the reason for educators' beliefs that computers can be integrated into the curriculum to support learners' individual development.

The assumption underlying the introduction of computers into schools is the understanding that computers can impact positively on performance and heighten student motivation, facilitating the re-engagement of student interest in subjects such as Mathematics (Dwyer, 1994). Although there is large-scale research to suggest that this is the case, there is a dearth of in depth case study type research in the area of how the introduction of computers into the lesson forces a change in pedagogical practice (Harding, 2005). The need to understand the processes underpinning educators' appropriation of a novel technology arises out of a body of research indicating that it is not the computer itself that is responsible for positive learning gains, but rather how the computer is used by a teacher (Cox, 2005). Previous research (Hardman, 2005) into how computers are used in schools has suffered the following limitations:

- They fail to account for the teacher's epistemic assumptions regarding the novel technology.
- They lack a sufficiently nuanced understanding of the social, historical and contextual structures that occur in an environment.
- They do not deal with the relationship between tools within the context of their use, leading to a failure to appreciate that use of a novel tool is

almost certainly contingent upon how other tools in the system are used (Russell & Schneiderheinze, 2005).

In their search for alternative models to explain learning, many researchers have turned to Vygotsky's notion of mediation, where a more competent peer or adult is viewed as assisting performance, bridging the gap between what the child knows and can do and what the child needs to know (Hardman, 2005). Vygotsky's study (as cited in Hardman, 2005) conceptualized this gap between unassisted and assisted performance as the zone of proximal development (ZPD) that 'space' where learning leads to development. Every experience that the child has is mediated through tools. Figure 2.1 illustrates the basic Vygotskian triadic representation of mediation, where the subject acts on the object using mediational tools. Vygotsky's findings are that humans use tools to change the world and are themselves transformed through tool use. This representation reflects learning as a transformation process rather than the transmission of knowledge. Computers can be viewed as the mediational tool used to facilitate learning.

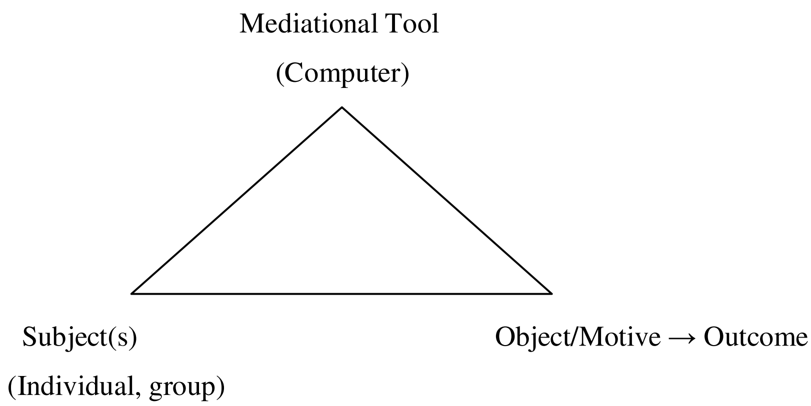


Figure 2.1 Source: First generation Activity Theory

2.4 The Khanya Project

In April 2004, one year after the launch of the Khanya Technology in Education Project, a research team from the University of Cape Town was consulted to evaluate the project. It is unusual for a newly launched programme to ask for an outcome evaluation so early in its existence. Programmes have a development trajectory of their own, and outcomes evaluations are usually not feasible at such an early stage. Only once it is stable in its service delivery and operationally mature, do outcome evaluations become more feasible (Louw & Muller, 2004).

It was too soon to produce a definitive evaluation of outcomes since the programme was still "settling down", developing and perfecting its delivery system amongst other things. It was too early in the development of the programme to expect it to deliver unequivocal outcomes (Louw & Muller, 2004). Nevertheless, it was accepted that research could still be conducted, serving a formative function to provide early feedback to Khanya on how it is doing in terms of achieving one of its key objectives (Louw & Muller, 2004): To assess whether learner performance in Grade 12 Mathematics improves as a result of curriculum delivery via technology. Technology comprised of computer hardware and the computer aided instruction software program Mastermaths.

Two research designs are utilised to strengthen conclusions about the programme effects. The first design involves a comparison of learner performance in schools using ICT in Mathematics education with schools not using computers for Mathematics. The main outcome of interest was learner performance. In the second design, essentially a time series design, learner performance is compared in Mathematics in 10 randomly selected schools from a list of 126 Khanya schools. This is referred to as the "Time Series Study" (Louw & Muller, 2004). The Grade 12 examination scores are analysed over the short time series of 2001 to 2003. The argument is that if the Khanya intervention is successful in the schools, one shall see a gradual change post-Khanya over time as depicted in Figure 2.2.

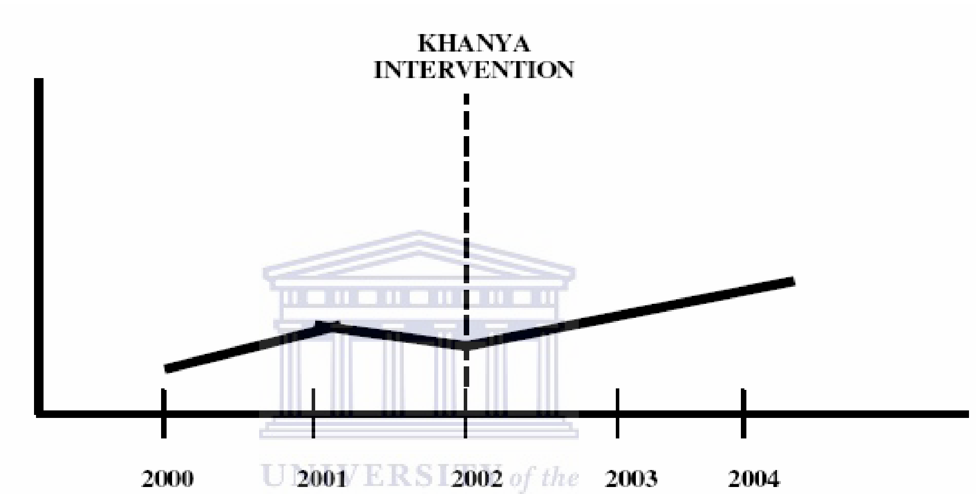


Figure 2.2 Source: Learner performance and mastermaths – Khanya Project

The results indicated that the Khanya intervention improves Mathematics performance in Grade 12 learners, although the evidence was not conclusive, since some of the schools showed no change after the intervention. It was found that in some of the schools, the technology was under-utilised, which could be the reason for the varying results. The researcher will attempt to adopt this theoretical framework inclusive of another dimension that will include an analysis of examination results of schools from varying socio-economic backgrounds to conduct research on the Khanya Project.

2.5 Conclusion

ICT has the potential to improve outcomes in Mathematics teaching/learning, although individual effects are sometimes weak and findings are inconsistent. Two of the challenges experienced by European countries are:

- Difficulty in integrating computers into classroom instruction
- Teachers' lack of knowledge in using computers as a teaching tool

Training and support of educators is imperative in order for them to buy into this innovation in education. Successful staff development programmes teach both ICT skills and related pedagogical skills, including how to integrate ICT in teaching.

The findings in the United Kingdom showed that learners who used subject-based Mathematics software achieved statistically higher scores in tests than learners who were taught similar concepts through traditional methods (BECTA, 2003). The second major study in the UK also confirmed that those learners who use ICT in Mathematics more frequently, perform much better than learners that use technology to a lesser extent. In the United States of America, many meta-analytic approaches are used to quantitatively analyse standardised examination scores. Sixteen of the studies conducted found that Mathematics standardised test scores are at least slightly higher in the group of learners that used ICT in Mathematics education. Nine of the sixteen studies showed a statistically significant difference in results after technology integration. Evaluations provide evidence that suggest that a high frequency of the use of technology provides a more positive effect on tests results (Kulik, 2003).

Some Nordic countries, Australia and New Zealand are among the countries that appear to have made investments in educational ICT that are large enough to allow most learners to gain access to the technology fairly frequently; and they are countries in which the technology does not appear to sit unused or to be infrequently used (OECD, 2005). In this group of countries investment in equipment has often been completed by extensive teacher training and patterns of computer use by learners both within the school and outside it, more often point to uses that emphasise educational and learning purposes. In these countries, one can observe an awareness of the importance of treating improved educational uses of ICT as a specific case of the general need to improve teaching and learning and to reform schools. A basic problem in gaining improved educational benefits from ICT, no matter how strong the benefits in terms of the production of ICT skills for the labour market and for everyday living, is that too frequently countries have seen it mainly as a technological issue, and not as an issue in school reform and school improvement (OECD, 2005).

Under the right circumstances, technology has been seen to have a positive impact in education. Literature has shown that to improve the quality of research, experts agree that there should be more longitudinal studies that chart the progress of the same learners over several years (Bergh, 2002). Also of significance, is that the impact of ICT's should be thoroughly investigated, to ascertain a qualified and viable "return on investment", (Bergh, 2002). Sayed's research (Sayed, 1998) confirms the need for investigations of ICTs in education in South Africa, suggesting that processes are required that will evaluate ICTs that are participatory and interactive, and that policy-makers should be involved in order to create a climate favourable for sustaining educational changes.

When trying to assess the educational impact of ICT, countries have different expectations about the ways in which ICT can improve educational outcomes (OECD, 2005). Two broad positions on the benefits that should be expected from investing in educational ICT can be observed. In the USA, there is a popular view that ICT can be judged by the extent to which it is able to improve learner performance in standardised examinations (Archibald, 2001). Another view is that ICT is an ideal tool for the achievement of lifelong learning: raising the motivation to learn (by giving learners more control over the content, timing the mode of their learning); and developing key learning skills such as co-operative learning, problem solving, information acquisition and analysis and autonomous learning (OECD, 2005).

The general belief is that ICT offers a powerful tool to improve the outcomes of education: improving the quality of teaching and learning, hence resulting in enhanced learner performance. The hypothesis of this mini-thesis research project: "Computer integration in Mathematics education for curriculum delivery enhances learner performance", is tested in the chapter Research design and methodology. Research is conducted on the Khanya Project, an initiative of the Western Cape Education Department, that explores the infusion of technology for curriculum delivery in Mathematics education. A study is conducted on the standardised matric Mathematics examination results for the pre-Khanya years and the post-Khanya intervention in an attempt to determine the effect of using computers in Mathematics lessons on learner performance.

Chapter Three

3. Research Design and Methodology

3.1 Introduction

The aim of the research is to determine if technology integration in Mathematics education enhances learner performance. The research design describes the plan or blueprint of an investigation to obtain answers to research questions or problems (Babbie & Mouton, 2001). The design focuses on the end product, the study that is being planned and the kind of results that are expected. The terms "quantitative" and "qualitative" are used frequently to identify different modes of inquiry or approaches to the research process. Burns (2000) describes qualitative research as being naturalistic, involving the importance of subjective experience of individuals, an ideographic approach and as a holistic analysis, as opposed to the criteria of reliability and statistical compartmentalisation of quantitative research.

3.2 Quantitative Research

The researcher will use the quantitative research approach to determine the quantity or extent of the phenomenon, i.e. technology in education being studied on learner achievement. Learner achievement is measured by data in the form of numbers. In addition, analysis is done by using statistics, tables and charts with discussions on how what they show relates to the hypothesis which will enable the researcher to obtain measurements and analysis of the properties of the phenomenon under investigation. The data collected from the Western Cape Education Department (WCED) is used to compute pass rates, average pass rates and various statistical analyses which are all quantitative measures.

Traditionally, quantitative research has its goal to make claims about an entire population of cases on the basis of a subset of a population (Ercikan, 2006). The population most often consists of people. In the context of this research study, the Grade 12 learners represent the population. One can characterise this class of research as making inferences of a certain type, from a sample of specimens to the entire population from which the specimens derive (Ercikan, 2006). The statistical apparatus provides a set of procedures to assess such issues, as the probability of making an erroneous inference about the population. Thus, if a statistical comparison in a study suggests a difference between pre-technology and post-technology Mathematics examination results and the statistical results are associated with a value of $p < 0.05$, the researcher knows that there is a probability of less than 5% that the difference between results prior to ICT and post ICT is mere coincidence.

Since it is generally impossible to study an entire population, researchers typically rely on sampling to acquire a section of the population to perform an experiment or observational study (Easton, 2006). It is important that the group selected be representative of the population, and not biased in a systematic manner. Randomisation is employed to achieve an unbiased sample. The most common sampling designs are simple random sampling and stratified random sampling (Easton, 2006). Simple random sampling is the basic sampling technique where a group of subjects (a sample) for study is selected from a larger group (a population). Each individual is chosen entirely by chance and each member of the population has an equal chance of being included in the sample. There may be factors which divide up the population into sub-populations (groups/strata) and we may expect the measurement of interest to vary among the different sub-populations (Easton, 2006). This has to be accounted for when selecting a sample from the population in order to obtain a sample that is representative of the population. This is achieved by stratified sampling. Stratified sampling techniques are generally used when the population is heterogeneous, or dissimilar, where certain homogeneous, or similar, sub-populations can be isolated (Easton, 2006). Simple random sampling is most appropriate when the entire population from which the sample is taken is homogeneous.

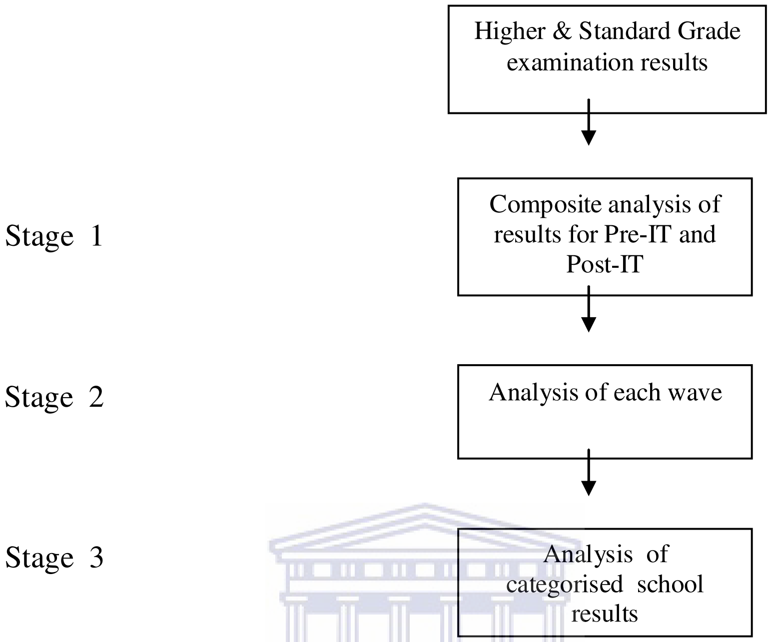
The main features of quantitative research are (Neuman, 2000) that

- It tests the hypothesis with which the researcher begins
- Concepts are in the form of distinct variables
- Measures are systematically created before data collection and are standardized
- Data are in the form of numbers from precise measurement
- Theory is largely causal and is deductive
- Procedures are standard and replication is assumed
- Analysis proceeds by using statistics, tables or charts and discussing how what they show relates to hypotheses

The Khanya Project study is aligned to the above attributes. Quantitative research relies on a positivist approach (Neuman, 2000) to social science. Neuman defines positivism as the approach of natural science that assumes cold, observable facts, quite distinct from ideas, values or theories. Burns (2000) states that research is positivist if there is evidence of quantifiable measures of variables, hypothesis testing and the drawing of inferences. The researcher will statistically analyse Grade twelve standardised Mathematics examination results for the period 1999 to 2005, which comprises of data in the form of numbers. Therefore a quantitative approach will be most suited for this investigation. Qualitative research follows an interpretive approach to understand a concept. Qualitative research will be appropriate in exploring learner perceptions and attitudes to ICT infusion in Mathematics education, but this research study investigates learner performance in the Mathematics Grade 12 standardised examinations prior to ICT integration compared to learner results after leveraging ICT in Mathematics education.

3.3 Research Procedure

The research procedure follows the design model below which represents the stages in the research process. Data for the years 1999 to 2005 was collected from the Examination Section of the Western Cape Education Department's (WCED) examination database. The data consist of the schools' details; including the school name, the grade of learners (Higher Grade or Standard Grade), the number of learners enrolled for the Grade 12 Mathematics examinations and the number of learners that passed the examination. Personal information such as the names of learners and the actual mark obtained by individual learners in the Mathematics examination could not be divulged due to confidentiality and ethical reasons. The Grade 12 Mathematics examination is the research instrument. The Higher Grade and the Standard Grade are two different Mathematics examinations; with Mathematics Higher Grade testing the more complex concepts. The Mathematics Higher Grade and Standard Grade results are therefore analysed separately in keeping with standardisation. Data is statistically analysed at three levels, as reflected in Stage 1, Stage 2 and Stage 3 of the model.



3.3.1 Stage One

Data for the Grade 12 standardised Mathematics examination results was collected over a period of seven years (1999 to 2005). This period of seven years comprised of the Pre-IT and a Post-IT period i.e. when no computers were used in Mathematics lessons (Pre-IT) and when ICT was used in the curriculum delivery of Mathematics (Post-IT). The years 1999 to 2001 are the Pre-IT years and from the year 2002 to 2005, groups of schools were selected for the Khanya intervention project, forming the Post-IT years. Since technology was implemented at different months of the same year for groups of schools, it seems reasonable to include a third analysis as the year of implementation together with the analysis of the Pre-IT and Post-IT years

A longitudinal study is conducted for the years 1999 to 2005. Longitudinal Research examines features of people or other units at more than one time (Neuman, 2000). It is a powerful approach, especially seeking answers to questions about system or social change over time. In stage one, the examination results are statistically analysed based on the proportion of learners passing prior to being exposed to ICT in Mathematics education, as compared to the results of learners who used computers in Mathematics education. The Higher Grade results for all the schools are analysed separately from the Standard Grade results of all schools. No covariates, such as socio-economic measures for learners are taken into account at this stage of the investigation. A stratified analysis is done where each school is considered a stratum. Data is statistically analysed for pre-IT, during the year of IT implementation and post-IT; to determine if the proportion of those passing within the particular school improves across time. The Cochran-Mantel-Haenszel methodology is used to test for changes in proportions across the implementation levels (Pre-IT, year of IT implementation and Post-IT). This is a stratified version of a Chi-square test. The analyses was done using the FREQ (frequency) procedure in the software package SAS. A more sophisticated analysis using Generalised Linear Models is also done on the data. In this analysis, logistic regression is used to model the outcome of pass/fail and account for the dependence of observations within the same school. The correlation structure for this dependence was taken to be compound symmetry.

3.3.2 Stage Two

For each year from 2002 to 2005, a group batch of schools received the Khanya intervention Programme, where computer labs were set up at schools for Mathematics education using the Mathematics software programme, Mastermaths. Each group of schools for each year is referred to as a wave. The first batch of schools to receive the Khanya intervention programme in 2002 is referred to as the pilot wave, the next wave, in 2003, the second wave, in 2004 the third wave and in 2005 the fourth wave. Therefore, for each year from 2002 onwards, a new set of learners were writing the Grade 12 Mathematics examinations after receiving Mathematics education via computers. In the second stage of the research design, data for each wave is analysed as a unit since all schools in a specific wave have been exposed to ICT in Mathematics education for approximately the same period of time. The grade twelve, also referred to as the matric standardised examination scores for the Pre-IT and the Post-IT years in each wave is analysed

3.3.3 Stage Three

For the purpose of validity, further analysis is conducted in stage three in an attempt to use triangulation. Winberg (1997) defines triangulation as finding ways of getting alternate and divergent viewpoints on research findings or the research process, which will improve the quality of the analysis. Schools in each wave are heterogeneous, varying with regard to location, demographics, resources and poverty index. The WCED ranks schools in five quintiles, based on the relative poverty of the communities surrounding the schools. Schools in quintile one are situated in the poorest communities, while those in quintile five are situated in the least poor communities. Each school is allocated a poverty index value in relation to its socio-economic status. Each wave of schools will be classified into their respective quintiles. The simple random sampling technique will not be appropriate since students in schools in each wave vary regarding socio-economic factors. The stratified random sampling design would have been the suitable methodology to select schools from a large population in order to analyse the Mathematics examination results for pre-technology and post-technology. However, the stratified random sampling design is not used since the condensed population qualifies using the population in its entirety. An experimental approach comprising of selecting a group of schools that use ICT (experiment) and comparing learner performance with another selected group of schools that do not use ICT (control) will not be necessary since each school acts as its own experiment and control, i.e. examination results for each school have been collected for three years prior to technology integration and post technology. Therefore reliability of the data will be implemented. Analysis of results for each of the five quintiles will provide a stronger indication of the effect of ICT in Mathematics education for the various types of schools in their respective quintiles. A linear regression is applied to determine whether there is a relationship between social status and improvement in pass rate. The number of learners enrolled for Mathematics in each school for the Pre-IT and Post-IT years is also explored in Stage Three.

3.4 Conclusion and Limitations

The research design reflects the three levels in which this the study will be conducted. Starting from a composite analysis of the matric standardised examination results in stage one to a structured analysis in stage two by grouping schools into waves. Each wave contained schools that had the Khanya intervention programme for the same time period. In the final stage three, further categorisation is established where schools in each wave are classified into quintiles, depending on the socio-economic background of the schools. Statistical analysis is conducted in each of the quintiles for the pass rates and the enrolment of learners in the pre-IT and Post-IT years.

A key limitation to this study is that vital data including learner details and learner marks for the grade twelve examinations could not be accessed due to confidentiality and ethical issues. An investigation of the symbol distribution of the Mathematics examination results for the Pre-IT and Post-IT years would have provided a clearer understanding of not just the pass rates for the Post-IT years compared to the Pre-IT years, but the quality of pass rates as well. Impact studies of systems are effective over a prolonged time frame in order to conduct a comprehensive study, but the Khanya Project is still in its infant stage. Longitudinal studies that chart the progress of the same learners through different grades up to grade twelve would have provided a more comprehensive set of results. Consideration should be given to these factors in further studies of technology in education.

Chapter Four

4. Results

4.1 Introduction

The results for each of stage one, stage two and stage three were analysed independently. Stage one was a composite analysis of all the grade 12 Higher Grade results and all the Standard Grade results for the years 1999 to 2005. Stage two comprised of an analysis of the Higher Grade and Standard Grade results in accordance with the wave format. In the final stage three, the schools in each wave were grouped according to their social index. The results were then statistically analysed for the various categories of schools according to their socio-economic status.

4.2 Stage one Results

The Higher Grade and the Standard Grade Mathematics scores for all schools were each statistically analysed for the three phases i.e.

- Pre-IT:

  The years when Mathematics was taught in the classroom in the conventional way without IT intervention.

- Implementation year:

    The year of IT implementation in Mathematics lessons.

- Post-IT :

    The years when technology was integrated in Mathematics education.

A stratified analysis was done where each school was considered a stratum. The Cochran-Mantel-Haenszel methodology was used to test for changes in proportions across the implementation levels (Pre, during and Post). The analysis was done using the **PROC FREQ** (frequency procedure of *SAS*®) in the software package *SAS*®.

The frequency table (Table 4.1) shows that there was no significant difference for the Higher Grade results ($p = 0.35$). The proportions passing the examinations goes from 69 %, 68 % and 71 % for the period Pre-IT, During IT and Post-IT respectively.

Table 4.1
Frequency Table of Higher Grade Mathematics Learners (summarised over schools) according to whether passed or failed and whether the examinations were Pre-IT, in the year of the IT implementation and Post IT implementation and with the relevant percentages added

		Failed	Passed	Total
Pre IT	# learners	534	1215	1749
	Table Percentage	11.9%	27.08%	38.98%
	Row %	30.53%	**69.47%**	
Year IT	# learners	244	513	757
	Table Percentage	5.44%	11.43%	16.87%
	Row %	32.23%	**67.77%**	
Post IT	# learners	575	1406	1981
	Table Percentage	12.81%	31.33%	44.14%
	Row %	29.03%	**70.97%**	
Total # of Learners		1353	3134	4487
	Row %	30.15%	69.85%	85

The pass rate for Pre-IT was 69.47 % and this rate dropped to 67.77 % during the year of IT implementation and then increased to 70.97 % during Post-IT implementation. Therefore there was a small increase of 3.20 % for Post-IT and the p-value associated with this increase was 0.35, indicating that the increase was not significant.

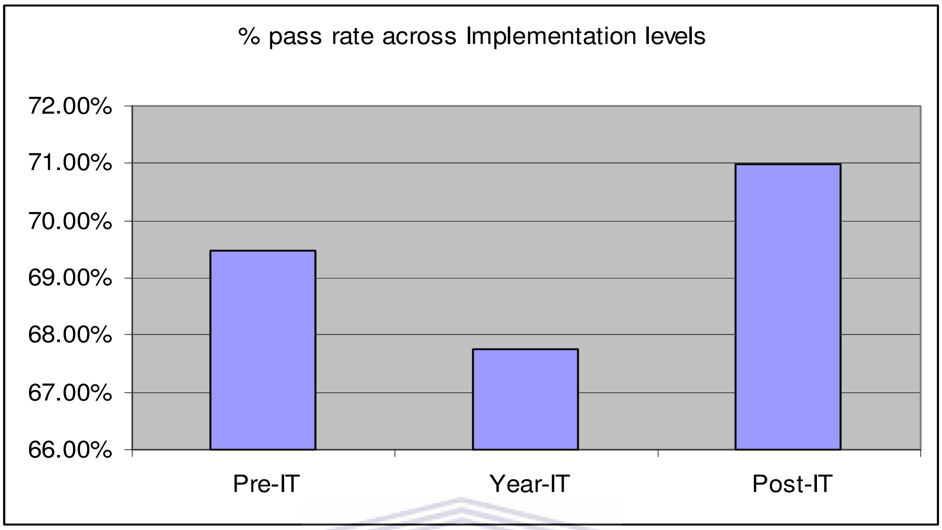


Figure 4.1
The % pass rate over the three levels of implementation for the Higher-grade Mathematics examination

The results for the Standard Grade (Table 4.2) indicate that the proportion of learners passing the Mathematics examination increases from 46% (Pre-IT), 54% (year of IT implementation) to 57% (Post-IT). This was a significant difference, especially compared to the Higher Grade results.

Table 4.2
Frequency Table of Standard Grade Mathematics Learners (summarised over schools) according to whether passed or failed and whether the examinations were Pre-IT, in the year of the IT implementation and Post IT implementation and with the relevant percentages added

		Failed	Passed	Total
Pre IT	# learners	12202	10393	22595
	Table Percentage	28.75%	24.49%	53.24%
	Row %	54.00%	**46.00%**	
Year IT	# learners	3395	39.81	7376
	Table Percentage	8.00%	9.38%	17.38%
	Row %	46.03%	**53.97%**	
Post IT	# learners	5358	7111	12469
	Table Percentage	12.62%	16.76%	29.38%
	Row %	42.97%	**57.03%**	
Total # of Learners		20955	21485	42440
	Row %	49.38%	50.62%	100.00

The pass rate for Pre-IT was 46 % and this rate increased to 53.97 % during the year of IT implementation and then increased to 57.03 % for Post-IT implementation phase (Table 4.2). Therefore there was a net increase of 11.03 % for Post-IT and the p-value associated with this increase was 0.0001, therefore the increase was significant.

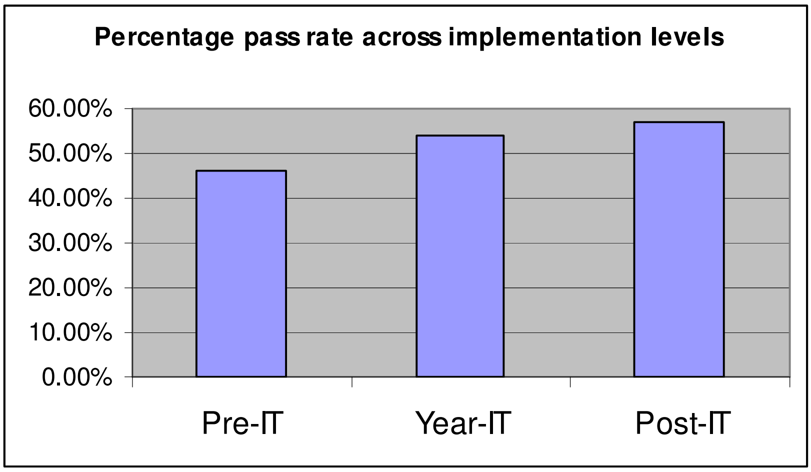


Figure 4.2
The Percentage pass rate over the three levels of implementation for the Standard-Grade Mathematics examination

4.3 Stage Two Results

At this stage, each wave of schools is analysed separately for the Higher Grade and Standard Grade Mathematics standardised examination results of Grade twelve.

4.3.1 Stage Two Higher Grade Results

For the pilot wave of the Higher Grade, there were 11 schools. Eight of the 11 schools were considered for analysis since the other 3 schools had too few numbers of learners enrolled for the Mathematics Higher Grade examination. The years 1999 to 2001 are the Pre-IT years when no computers were used in Mathematics lessons. The Khanya intervention programme was implemented in the latter part of 2001, therefore the years 2002 to 2005 are the Post-IT years when technology was integrated in Mathematics education.

Six out of the 8 schools showed an increase in pass rates for Post-IT as reflected in Table 4.3. There was an increase in pass rate from 68% to 73% after technology integration; a small increase of 5%. The p-value was 0.06 which is a 0.01 increase of 0.05 and may not be deemed to be significant.

Table 4.3
Pilot Wave Higher Grade pass rate for Pre-IT and Post-IT

School	Pre-IT	Post-IT	Increase or Decrease
Bridgton	90%	75%	decrease
Garlandale	76%	78%	increase
Harold Cressy	39%	45%	increase
Klein Nederburg	39%	45%	increase
Livingstone	99%	98%	decrease
Luhlaza	43%	84%	increase
Sarepta	59%	61%	increase
South Pennin.	92%	93%	increase
	68%	73%	Pass rate increased in six schools

The associated Chi-squared Test Statistic for the summarised table for all Higher Grade Pilot Wave schools was equal to 3.32, 1 degree of freedom with a p-value of 0.069 which is not significant.

Thus there was a small improvement in the pass rate after infusing ICT in Mathematics education. The Chi-Squared test performed above was not completely valid because it is the summary over the total number of schools, during the academic years 1999 to 2005 in the first wave.

The pass rates before ICT and after ICT in Mathematics Higher Grade for the pilot wave are shown in Figure 4.3 below. For eight of the schools in Figure 4.3 the pass rates were approximately equal before and after implementation, with a very small increase in pass rate after ICT infusion in Mathematics education, except for Luhlaza with an increase of 41% and Bridgton High School that had a decrease of 15%

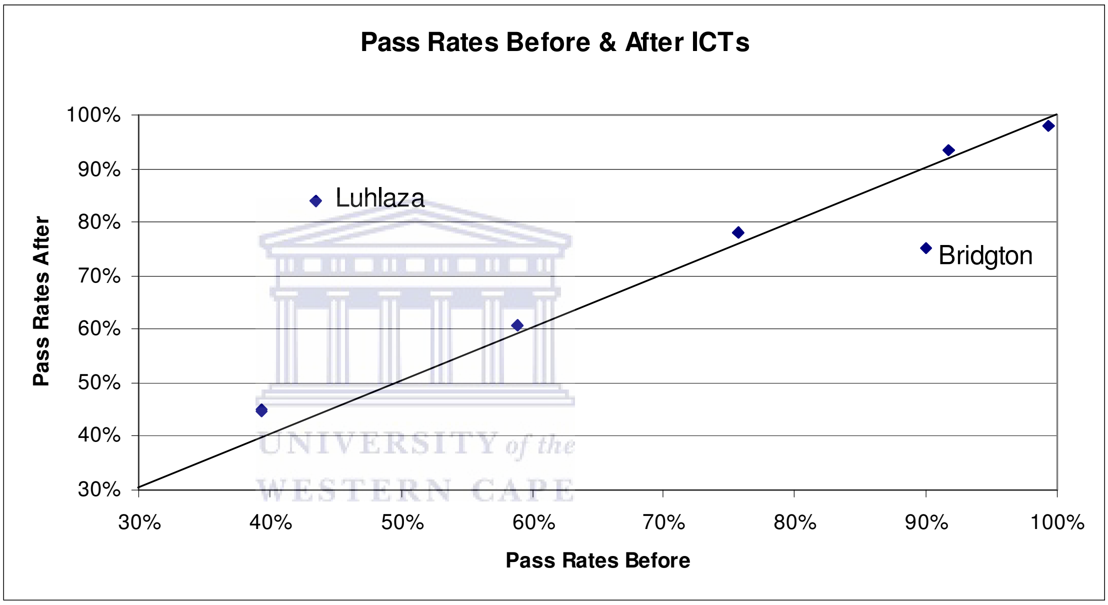


Figure 4.3
Pass rates for Pre-IT and Post- IT implementation in the first wave HG schools

For the second wave, the years 1999 to 2001 are the Pre-IT years. The project was implemented in 2002, therefore the years 2002 to 2005 are the Post-IT years. The Higher Grade results of 23 schools were analysed. Seventeen of the 23 schools showed an increase in pass rates for Post-IT as reflected in Table 4.4. There was an increase in pass rate from 72% to 73% after technology integration: a very small increase of 1 %. Although the overall percentage increase was only 1% for this wave, 74% (17 out of 23) of the schools had an increase in pass rate after technology implementation (Figure 4.4).

Table 4.4
Second Wave Higher Grade pass rate for Pre-IT and Post-IT

School	Pre-IT	Post-IT	Difference	Increase or Decrease
Atlantis	73%	88%	+15	increase
Berg Rivier	22%	57%	+35	increase
Bernadino Heights	60%	46%	-14	decrease
Blackheath	67%	65%	-02	decrease
Cosat	77%	91%	+14	increase
Grabouw	100%	95%	-05	decrease
Groenberg	63%	67%	+04	increase
Kasselsvlei	88%	63%	-25	decrease
Kensington	70%	83%	+13	increase
Ladismith	92%	94%	+02	increase
Luckhoff	43%	45%	+02	increase
Mondale	58%	84%	+26	increase
New Orleans	36%	80%	+44	increase
Oudtshoorn	96%	98%	+02	increase
Pacaltsdorp	38%	86%	+48	increase
Piketberg	96%	100%	+04	increase
Proteus	47%	52%	+05	increase
Rylands	70%	89%	+19	increase
Schoonspruit	81%	70%	-11	decrease
Simon's Town	58%	72%	+14	increase
Sinethemba	14%	34%	+20	increase
Worcester	40%	53%	+13	increase
Zwartberg	95%	91%	-04	decrease
	72%	**73%**		Pass rate increased in 17 schools

Figure 4.4 illustrates that the majority of the schools in the second wave had an increase in pass rate after using technology in Mathematics teaching. The majority of the schools fell above the line of no change. Schools such as Pacaltsdorp and New Orleans had high increases of 48% and 44% respectively.

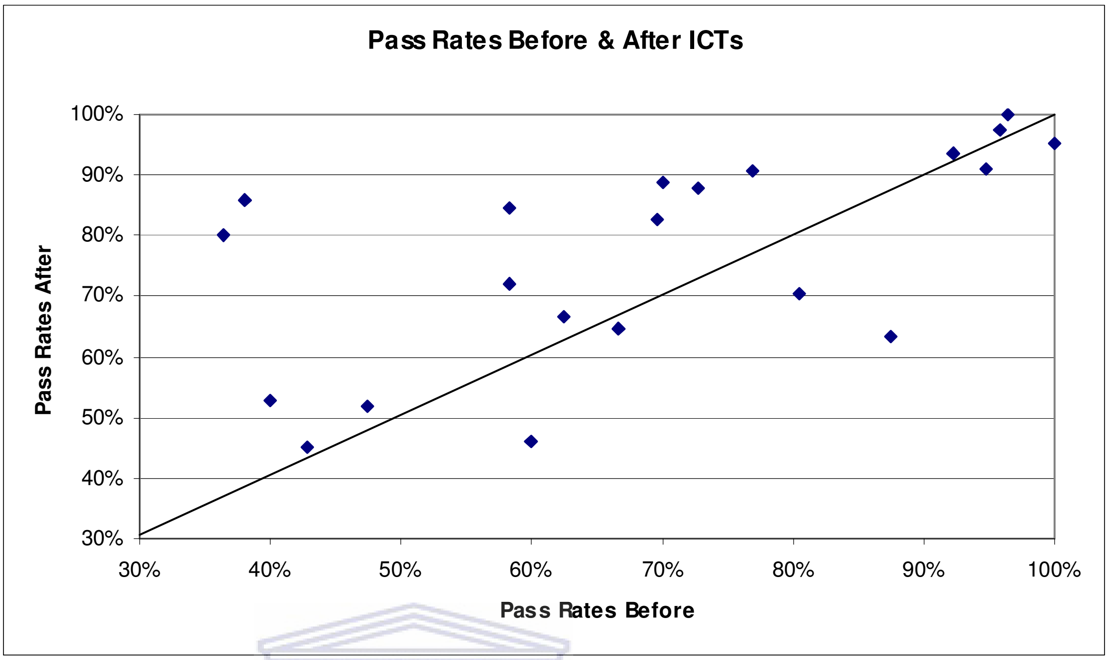


Figure 4.4
Pass rates before and after IT implementation for the Second Wave Higher Grade schools

In the third wave, the years 2000 to 2002 are the Pre-IT years while the years 2003 to 2005 are the Post-IT years. The examination results of 12 schools were analysed. Only 4 of the 12 schools showed an increase in pass rates for Post-IT as reflected in Table 4.5. There was an average decrease of 10% in the pass rate after technology integration. Figure 4.5 represents the pass rates before IT integration and after IT integration. Most schools had a small decrease in pass rates after using ICT in Mathematics education except Malibu and Spine Road that had decreases of 16% and 17% respectively. The only high increase in pass rate for Post-IT was Sophumelela that had an increase of 15%.

Table 4.5
Third Wave Higher Grade pass rates

School	Pre-IT	Post-IT	Inc/Dec
Belgravia	75%	80%	+05%
Bellville High	100%	97%	-03%
Bulumko	40%	39%	-01%
Cravenby	81%	76%	-05%
Gordon	29%	27%	-02%
Kwamfundo	50%	50%	00%
Kylemore	75%	83%	+08%
Malibu	74%	58%	-16%
Norman Hen.	79%	76%	-03%
Percy Madala	67%	75%	+08%
Sophumelela	33%	48%	+15%
Spine Road	67%	50%	-17%
	78%	68%	-10%

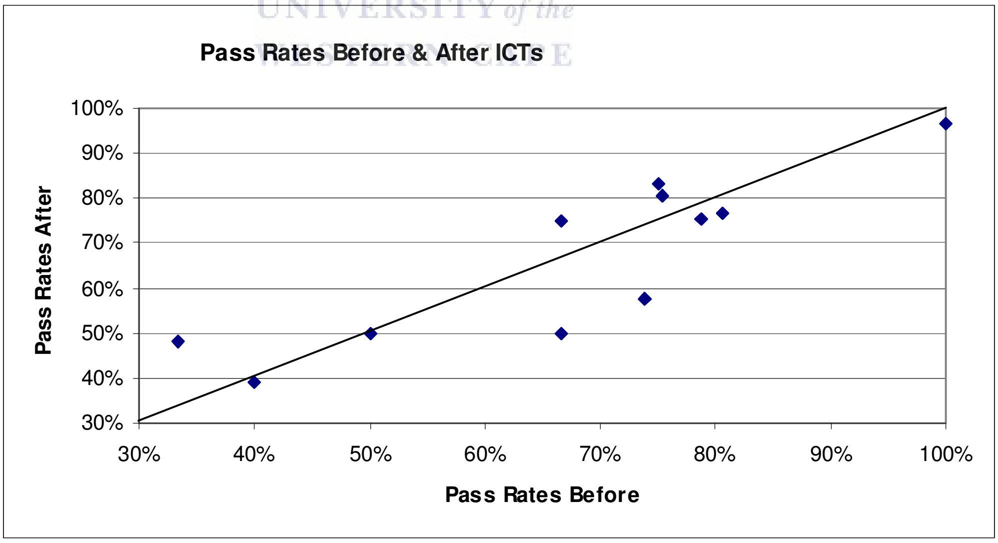


Figure 4.5
Pass rates before and after IT for the Higher Grade Third Wave Schools

Most of the learners in schools that fell into wave four were enrolled for Mathematics Standard Grade, therefore an analysis could not be done on these waves since the numbers of results were too small, however an analysis is done for these schools in the Standard Grade section.

4.3.2 Stage Two Standard Grade Results

The Standard Grade examination scores of all eleven schools in the pilot wave were taken for analysis. The percentage pass rate was calculated for all schools for the years 1999 to 2005 (Table 4.5). The years 1999 to 2001 are the Pre-IT years when no computers were used in Mathematics while the years 2002 to 2005 are the Post-IT years when computers were used in Mathematics lessons.

Table 4.6

Standard Grade Percentage pass rate for Pre-IT and Post-IT years in the Pilot Wave

Year	Percentage Pass
1999	59
2000	61
2001	53
2002	67
2003	62
2004	67
2005	61

A severe drop in the pass rate occurred from 2000 to 2001 (Figure 4.6). Possible reasons could be too high standards of the examinations. In 2002 the pass rate increased by 14%. The year 2002 was the first year that computers were used in the Mathematics curriculum. Computers were installed in the second half of the year therefore ICT was only used for the latter part of the year in Mathematics education. The pass rate was reasonably stable for years 2002 to 2005. The average pass rate for the post-IT years (2002-2005) was higher than the pass rates for the pre-IT years (1999-2001) as shown in Figure 4.6. From Figure 4.6 below it appears that computers had a positive effect on the learner performance in the standardised matric Mathematics examinations.

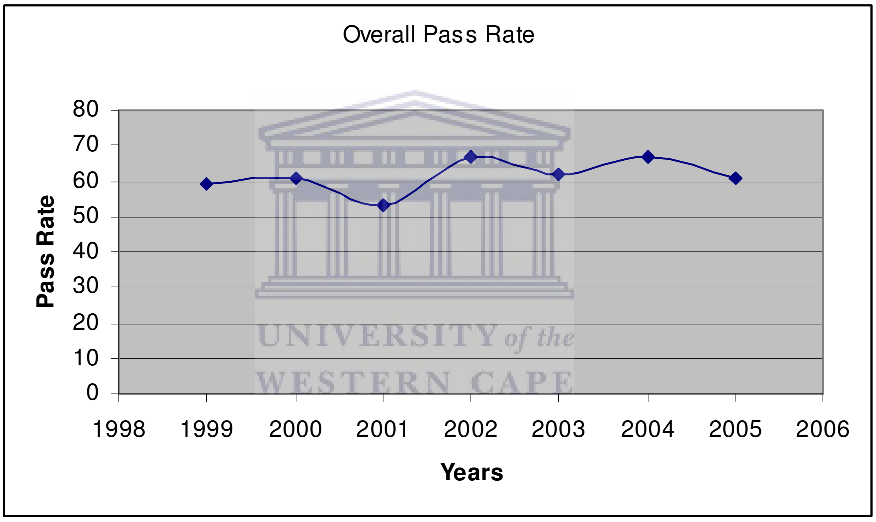


Figure 4.6

Overall results of Standard Grade scores in the First Wave

The Standard Grade examination scores of all 42 schools in the second wave were taken for analysis. The percentage pass rate was calculated for all schools for the years 1999 to 2005 (Table 4.7). The years 1999 to 2001 were the Pre-IT years. The year 2002 was the implementation year when computers were installed in the second wave schools. The years 2003 to 2005 were the Post-IT years.

Table 4.7

Standard Grade pass rate for Pre-IT and Post-IT years in the second Wave

Year	Percentage Pass
1999	44
2000	44
2001	51
2002	58
2003	54
2004	59
2005	60

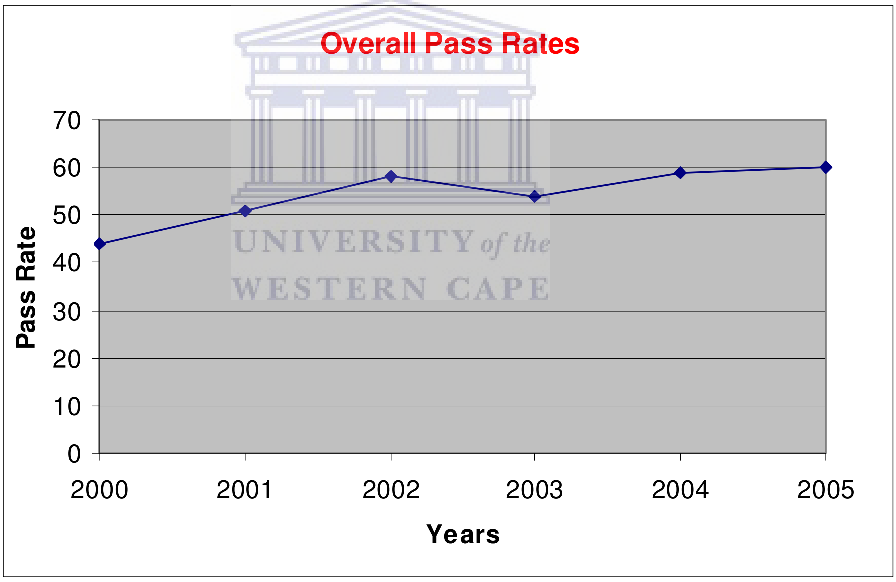


Figure 4.7

Overall results of Standard Grade scores in the Second Wave

In Figure 4.7 the pass rate from 1999 to 2000 for the Pre-IT years was consistent (44%) and then increased to 51% in 2001. For the Post-IT years, the pass rate increased to 59% in the year 2002. In the year 2003, the pass rate decreased to 54% and then increased to 60% in 2004, and remained consistent for 2005. The average pass rate for the Post-IT years was higher than the average pass rate for the Pre-IT years. It appears that using computers in Mathematics education impacted positively on student performance.

The Standard Grade examination scores of all 30 schools in the third wave were taken for analysis. The percentage pass rate was calculated for all schools for the years 2000 to 2005 (Table 4.8). The years 2000 to 2002 were the Pre-IT years while the years 2003 to 2005 were the Post-IT years.

Table 4.8 Standard Grade pass rate for Pre-IT and Post-IT years in the Third Wave

Years	Percentage Pass
2000	35
2001	42
2002	51
2003	58
2004	57
2005	48

There was a gradual increase in the pass rates for the Pre-IT years 2000 to 2002 (Figure 4.8).The pass rate continued to increase for the Post-IT year 2003 remaining stable for 2004 until it declined in the year 2005. The lower pass rate could be explained by the higher standards in the Mathematics examination in that year since the majority of the schools showed a decline in the pass rate for the year 2005. The average pass rate for the Pre-IT years was 43% while the average pass rate for the Post-IT years was 54%. Therefore there was an increase of 11% in the pass rate for the Post IT years.

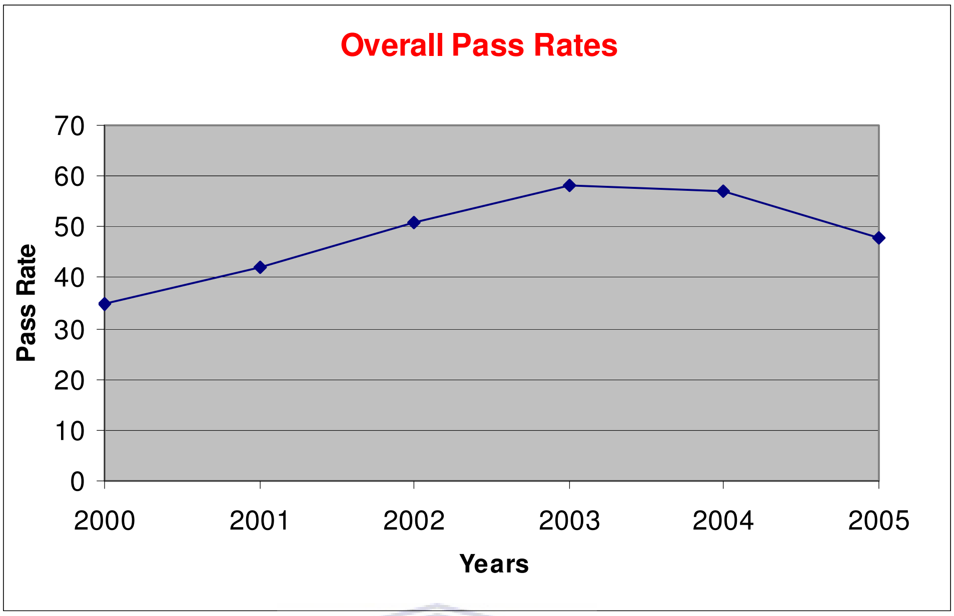


Figure 4.8

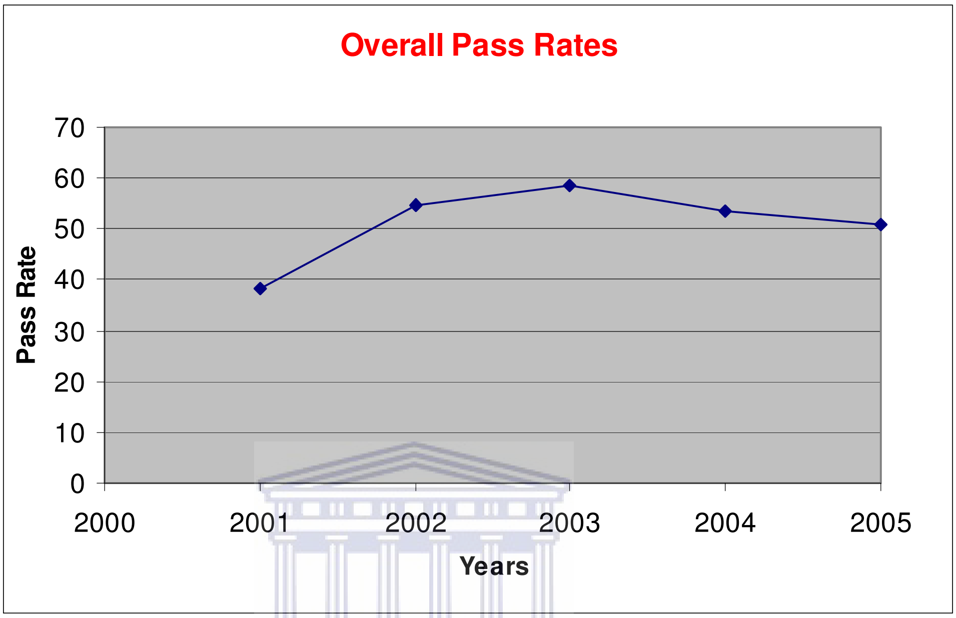
Overall results of Standard Grade scores in the Third Wave

The results for all twenty two schools in the Fourth Wave were analysed. There was a steady increase in the pass rates for the Pre-IT years 2001 to 2003 (Table 4.9). There was a decrease of 4% in the Post –IT year 2004 and a further drop of 3% in 2005.

Table 4.9
Standard Grade pass rate for Pre-IT and Post-IT years in the Fourth Wave

Years	Percentage Pass
2001	38%
2002	55%
2003	58%
2004	54%
2005	51%

Figure 4.9
Overall results of Standard Grade scores in the Fourth Wave



For the fifth wave, computers were installed in schools at various times in the year 2005. In some schools, the Khanya Labs were only set up in the latter part of the year 2005; therefore technology was not used adequately in Mathematics education that warrants analysis of the examination results for that wave.

4.4. Stage Three Results

Schools were categorised into groups according to the socio-economic status of the communities in which the schools were located. Each of the groups, starting from the affluent schools that were grouped into the low poverty (LP) Quintile up to Quintile one which consisted of schools from the poorest communities. The poverty levels increased, moving from the low poverty (LP) Quintile down to Quintile one. The Mathematics examination results were analysed in an attempt to determine how ICT integration in Mathematics education affects the different classes of schools regarding the pass rates and enrolment figures for the schools. This analysis of homogenous groupings was significant in order to determine the effect of ICT on the Mathematics performance of students from across the socio-economic spectrum.

4.4.1 Stage Three Higher Grade Results

Table 4.10 represents schools from all five quintiles of the first wave that were analysed for the pass rates and enrolment of students for Mathematics during pre-technology and post-technology.

Table 4.10

Higher Grade pass rates and enrolment figures for schools classified into social index for the first wave

School	Social Status	Quintiles	Improved Enrolment	Improved Enrolment	PreTech Enrol.	PostTech Enrol.	PreTech Pass Rate	PostTech Pass Rate	Improved Pass Rate
South Pennin.	0.31	LP	62%	44	48	91.5	92%	93%	1%
Sarepta	0.36	LP	37%	16	34	49.5	59%	61%	2%
Garlandale	0.37	LP	11%	4	37	41.25	76%	78%	2%
Livingstone	0.38	LP	20%	33	149	182.25	99%	98%	-1%
Harold Cressy	0.41	LP	-18%	-27	160	133.5	39%	45%	6%
Klein Nederburg	0.57	4	39%	16	33	48.75	39%	45%	6%
Excelsior	0.61	3	77%	3	2	4.5	100%	83%	-17%
Bridgton	0.69	2	-50%	-8	20	12	90%	75%	-15%
Mandlenkosi	0.72	2	136%	17	4	21	75%	68%	-7%
Luhlaza	0.77	2	-20%	-4	23	18.75	43%	84%	41%
Oscar Mpetha	0.79	1	148%	23	4	27	75%	36%	-39%

The schools were sorted according to their social status; starting from the more affluent schools(South Penninsula with Quintile LP and social status of 0.31) proceeding down to the poorest school (Oscar Mpetha with Quintile 1 and social status 0.79). All four schools in the LP Quintile had an increase in the pass rate except Livingstone that had a small decrease of 1%. Four schools also showed a substantial improvement in the enrolment for Mathematics except Harold Cressy that had a drop of 18% in enrolment. The one school in Quintile 4 had a significant improvement in enrolment of 39% together with an increase of 6% in pass rate. The only school in Quintile 3 improved enrolment by 77% but its pass rate declined by 17%. Of the three schools in Quintile 2, two schools enrolment dropped by 50% and 20% while one school experienced an improvement of 136%.In two of these schools, the pass rate decreased while one school had an increase of 41%. In the poorest school (Quintile 1) there was a substantive improvement of 148% in the enrolment but a 39% drop in the pass rate.

A scatter-plot was drawn for the bivariate variables together with the trendline (Table 4.10). The regression function and the r^2 values were derived. The coefficient of determination r2 indicates the percentage change in the dependent variable that can be explained to the independent variable. The correlation coefficient r, calculates the strength of the linear relationship between the dependent and the independent variable.

The social index value is small for the affluent communities and numerically larger for the poorer communities (Table 4.10). A straight line was fitted to all 11 points. The R squared was equal to 0.0203. When $r^{2\ \text{falls}}$ in the range:
$0 < r^2 < 0.25$ it is indicative of a very weak relationship. From the fitted line it could be deduced that there was a very weak correlation between social status

and pass rate. Only 2% of the variability in the "improvement of the pass rate" could be explained by the social status.

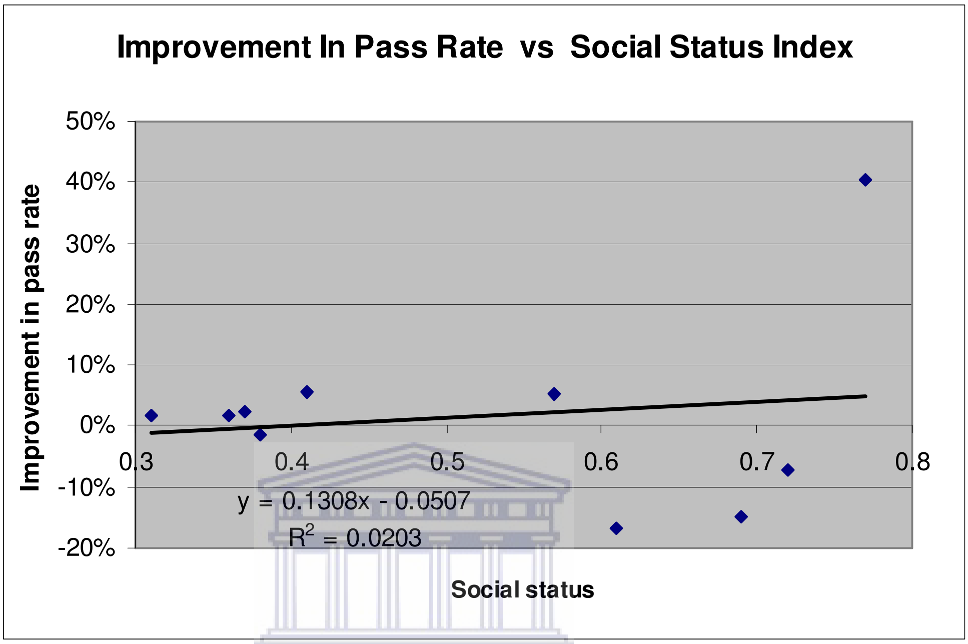


Figure 4.10
The improvement in Higher Grade Mathematics pass rate for the different social index in the first wave schools

A study of the improvement in the enrolment figures for the Post-IT period in the different socio-economic categories was also conducted. From the graph that follows (Figure 4.11), it is evident that two schools, Mandlenkosi and Oscar Mpetha from the poorer communities experienced extremes in enrolment of 136% and 148% respectively after ICT integration in Mathematics education. However, there is a weak correlation between improvement in enrolment and social status since the r^2 value was less than 0.25. Social status explained only 7 % of the variation in improvement in enrolment.

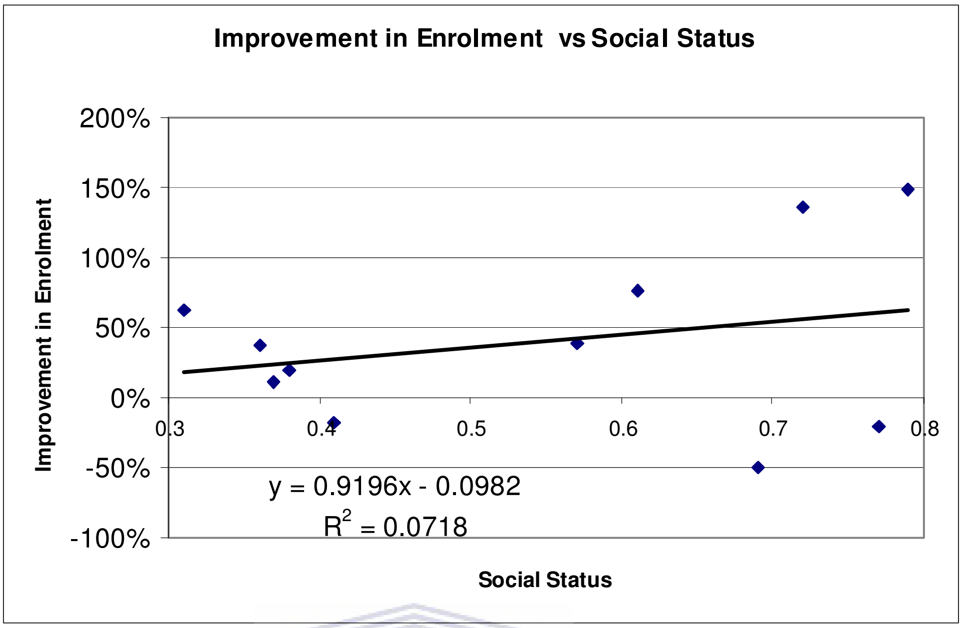


Figure 4.11
The improvement in Higher Grade Mathematics enrolment for the different social index in the first wave schools

In the second wave, the majority of the schools (5 out of 8), categorised in the LP Quintile had an improvement in the enrolment with Bernadino Heights showing a marked improvement of 94% (Table 4.11). Rylands High had a 0% improvement while the remaining two schools showed a small decline in the enrolment. Six of the eight schools improved their pass rates in Mathematics. Therefore, there was an overall improvement in the enrolment and pass rates for the LP schools. All schools in the 4th Quintile had a vast improvement in the enrolment and all schools except two schools had an increased pass rate. Three of the five schools in Quintile 3 improved their enrolment and had an improved pass rate. There was only one school in Quintile 2 that had a drop in the enrolment but an improvement of 44% in the pass rate. Of the two schools in the 1st Quintile, Sinethemba had an improvement of 104% in enrolment while Worcester had a drop of 79% in enrolment. Both of the same schools had an improved pass rate of 20% and 13%, respectively.

Table 4.11

Higher Grade pass rates and enrolment figures for schools classified into social index for the second wave

School	Social Status	Quintiles	Improved Enrolment	Improved Enrolment	PreTech Enrol.	PostTech Enrol.	PreTech Pass Rate	PostTech Pass Rate	Improved Pass Rate
Oudtshoorn	0.27	LP	22%	17.75	73	90.75	96%	98%	2%
Simon's Town	0.29	LP	44%	6.75	12	18.75	58%	72%	14%
Piketberg	0.32	LP	-9%	-2.5	28	25.5	96%	100%	4%
Grabouw	0.36	LP	19%	2.75	13	15.75	100%	95%	-5%
Ladismith High	0.38	LP	57%	10.25	13	23.25	92%	94%	2%
Rylands	0.38	LP	0%	0.25	80	80.25	70%	89%	19%
Kensington	0.39	LP	-6%	-1.25	23	21.75	70%	83%	13%
Bernadino Heights	0.4	LP	94%	17.75	10	27.75	60%	46%	-14%
Zwartberg	0.48	4	43%	275.25	498	773.25	95%	91%	-4%
Mondale	0.49	4	34%	9.75	24	33.75	58%	84%	26%
Luckhoff	0.51	4	107%	16.25	7	23.25	43%	45%	2%
Blackheath	0.52	4	72%	6.75	6	12.75	67%	65%	-2%
Atlantis	0.54	4	77%	13.75	11	24.75	73%	88%	15%
Proteus	0.55	4	6%	1.25	19	20.25	47%	52%	5%
Groenberg	0.6	3	-17%	-1.25	8	6.75	63%	67%	4%
Kasselsvlei	0.6	3	48%	15	24	39	88%	63%	-25%
Schoonspruit	0.6	3	24%	9.75	36	45.75	81%	70%	-11%
Berg Rivier	0.61	3	55%	6.75	9	15.75	22%	57%	35%
Pacaltsdorp	0.66	3	-120%	-15.75	21	5.25	38%	86%	48%
New Orleans	0.73	2	-38%	-3.5	11	7.5	36%	80%	44%
Sinethemba	0.8	1	104%	30.25	14	44.25	14%	34%	20%
Worcester	0.8	1	-79%	-10.75	19	8.25	40%	53%	13%

There is a greater increase in the pass rate in the poorer schools compared to the LP schools (Figure 4.12). There is a weak correlation between the social status and improvement in pass rate. Only 12 % of the variation in improvement in pass rate is explained by the social status.

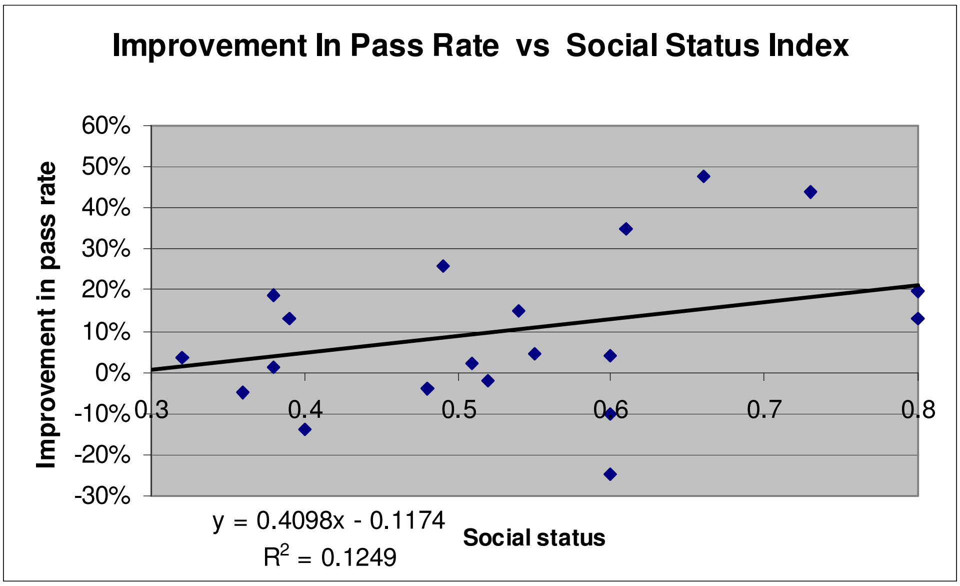


Figure 4.12
The improvement in Higher Grade Mathematics pass rate for the different social index in the second wave schools

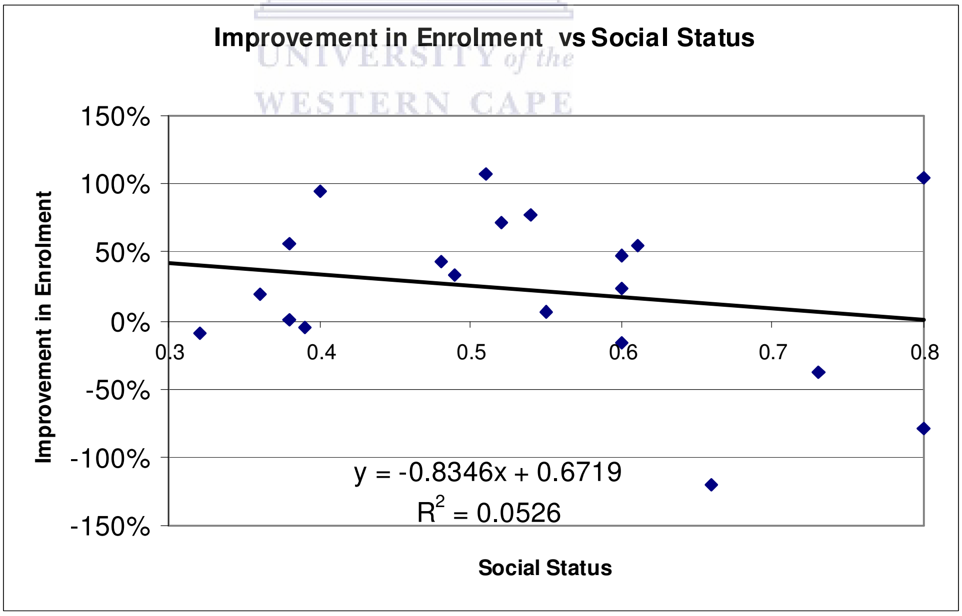


Figure 4.13
The improvement in Higher Grade Mathematics enrolment for the different social index in the second wave schools

In the second wave, the enrolment figures vary for the different categories of schools. No clear relationship could be determined for the schools in different social status compared to improvement in enrolment.

In the third wave, two of the three schools in the LP Quintile had an improved Mathematics enrolment with Gordon showing a substantial improvement of 130% while all three school's pass rate declined by a small margin (Table 4.12). All four schools in Quintile four had significant improvements in the enrolment but only Belgravia had an improved pass rate. Both schools in the third Quintile had enormous improvements of 163% and 129%, but Bulumko had a minimal decline in pass rate of 1%. All three schools in Quintile one had remarkable increases in enrolment while two schools improved their pass rate by 8%.

Table 4.12

Higher Grade pass rates and enrolment figures for schools classified into social index for the third wave

School	Social Status	Quintiles	Improved Enrolment	Improved Enrolment	PreTech Enrol.	PostTech Enrol.	PreTech Pass Rate	PostTech Pass Rate	Improved Pass Rate
Bellville HTS	0.12	LP	11%	13	110	123	100%	97%	-3%
Norman Henshil.	0.2	LP	-30%	-16	61	45	79%	76%	-3%
Gordon	0.36	LP	130%	26	7	33	29%	27%	-2%
Belgravia	0.44	4	47%	35	57	92	75%	80%	5%
Cravenby	0.48	4	9%	3	31	34	81%	76%	-5%
Malibu	0.52	4	54%	17	23	40	74%	58%	-16%
Spine Road	0.56	4	38%	7	15	22	67%	50%	-17%
Sophumelela	0.7	2	163%	26	3	29	33%	48%	15%
Bulumko	0.76	2	129%	18	5	23	40%	39%	-1%
Kwamfundo	0.79	1	167%	20	2	22	50%	50%	0%
Kylemore	0.79	1	100%	8	4	12	75%	83%	8%
Percy Madala	0.82	1	120%	9	3	12	67%	75%	8%

More schools in the lower quintile (low socio-economic status) experienced a higher pass rate as compared to schools in the relatively higher socio-economic communities (quintiles LP and 4) (Fig. 4.14). However the correlation between the schools is weak because the r^2 value is also below 0.25. Social status only accounts for 14% of the variation in improvement in pass rate.

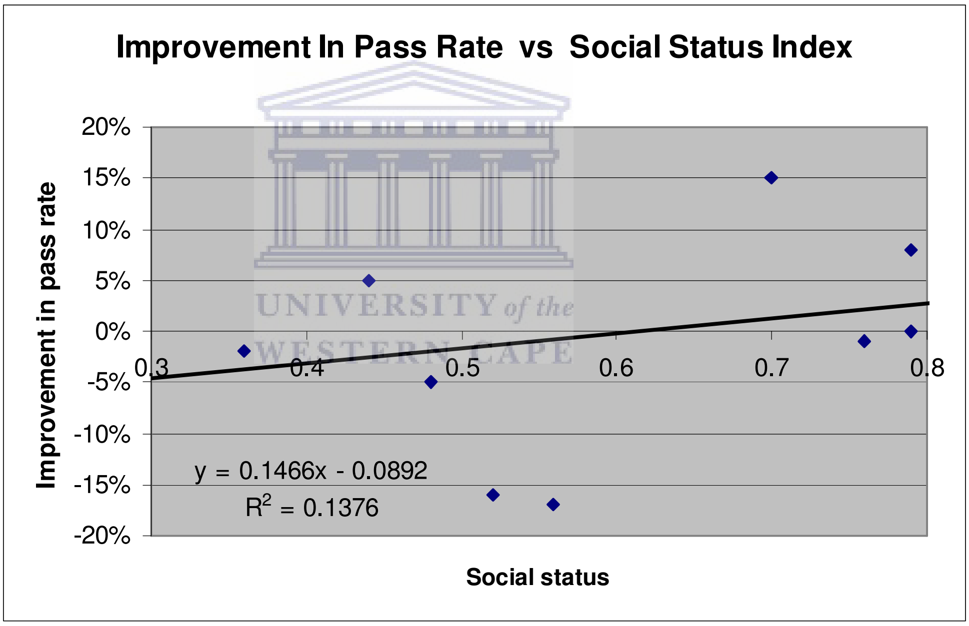


Figure 4.14
The improvement in Higher Grade Mathematics enrolment for the social index in the third wave of schools

The majority of the schools in all of the quintiles showed an increase in enrolment but the five schools from the poorest communities (quintiles 1 and 2) each had an extensive increase of more than 100% (Fig. 4.15). The correlation between social status and improvement in enrolment was significantly different from zero. Zero indicates no existing relationship and when r^2 falls in the range: $0.5 \leq r^2 \leq 0.75$ it is indicative of a moderate relationship between the social status and the improvement in enrolment. Social status accounted for 56% of the variation in improvement in enrolment.

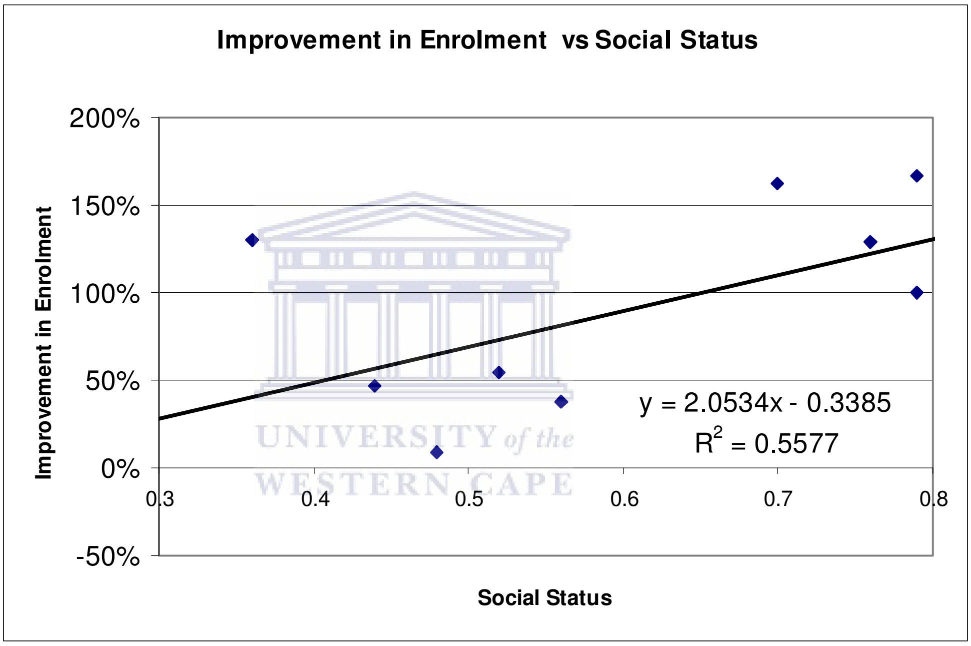


Figure 4.15
The improvement in Higher Grade Mathematics enrolment for the different social index in the third wave schools

4.4.2 Stage Three Standard Grade Results

Four out of five of the LP schools had a decline in enrolment but four of the schools also had an improvement in the pass rate (Table 4.13). There was one school (Klein Nederburg) in the fourth quintile that had an improvement in enrolment of 14% and a pass rate of 7% after ICT integration in Mathematics education. The one school in the third quintile had an improvement of 12% in enrolment and a decline of 33% in the pass rate. Two of the three schools in quintile two had improvement in enrolments and all three schools' pass rate increased. Oscar Mpetha of the first quintile had an improvement in the enrolment and also the pass rate.

Table 4.13

Standard Grade pass rates and enrolment figures for schools classified into social index for the first wave

School	Social Status	Quintiles	Improved Enrolment	Improved Enrolment	PreTech Enrolment 3yrs	PostTech Enrolment 3yrs	PostTech Enrolment 4yrs	PreTech Pass Rate	PostTech Pass Rate	Improved Pass Rate
South Penninsula	0.31	LP	-23%	-83	398	315	420	59%	85%	26%
Sarepta	0.36	LP	2%	5	294	299	398	54%	69%	15%
Garlandale	0.37	LP	-4%	-16	457	441	588	51%	54%	3%
Livingstone	0.38	LP	-21%	-75	388	314	418	80%	78%	-2%
Harold Cressy	0.41	LP	-8%	-16	214	198	264	50%	51%	1%
Klein Nederburg	0.57	4	14%	36	238	274	365	50%	57%	7%
Excelsior	0.61	3	12%	14	104	118	157	74%	41%	-33%
Bridgton	0.69	2	2%	2	138	140	187	69%	77%	8%
Mandlenkosi	0.72	2	-39%	-25	76	51	68	49%	59%	10%
Luhlaza	0.77	2	6%	16	258	274	365	59%	81%	22%
Oscar Mpetha	0.79	1	34%	89	219	308	411	42%	48%	6%

Of the 11 schools studied, only 2 showed deterioration in pass rate; one school (Excelsior) showed a severe deterioration of 33% (Figure 4.16). Amongst the 9 schools showing improvement in pass rates, two of them had a pass rate of more than 20%. A regression analysis was done to determine whether there is a relationship between social status and improved pass rate. The r^2 value of 0.004 indicates an extremely weak relationship between the two factors. The social index accounted for almost 0% of the variation in the pass rates. Therefore all categories of the social groupings showed a similar trend of an increase in pass rate after technology intervention in Mathematics education.

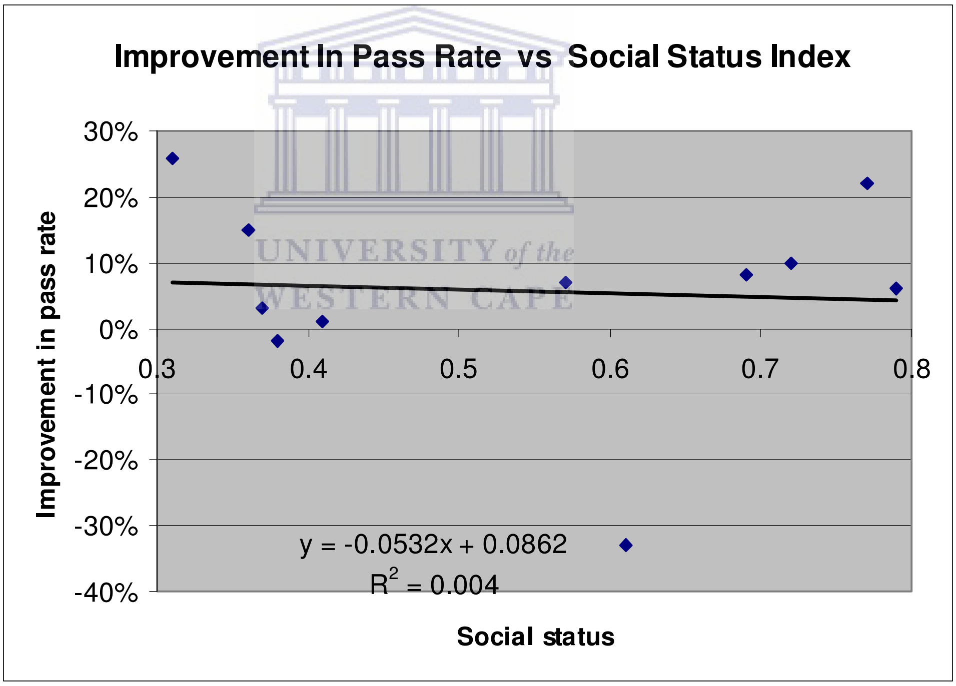


Figure 4.16

The improvements in Standard Grade Mathematics pass rates for the different social index in the first wave schools

The poorer schools showed a greater increase in enrolment than the low poverty (LP) schools (Figure 4.17). Students that convert from Standard Grade to Higher Grade could account for the decrease in the Standard Grade enrolment of the LP schools. A weak relationship exists, with social status accounting for 15% in the variation of the improvement in enrolment.

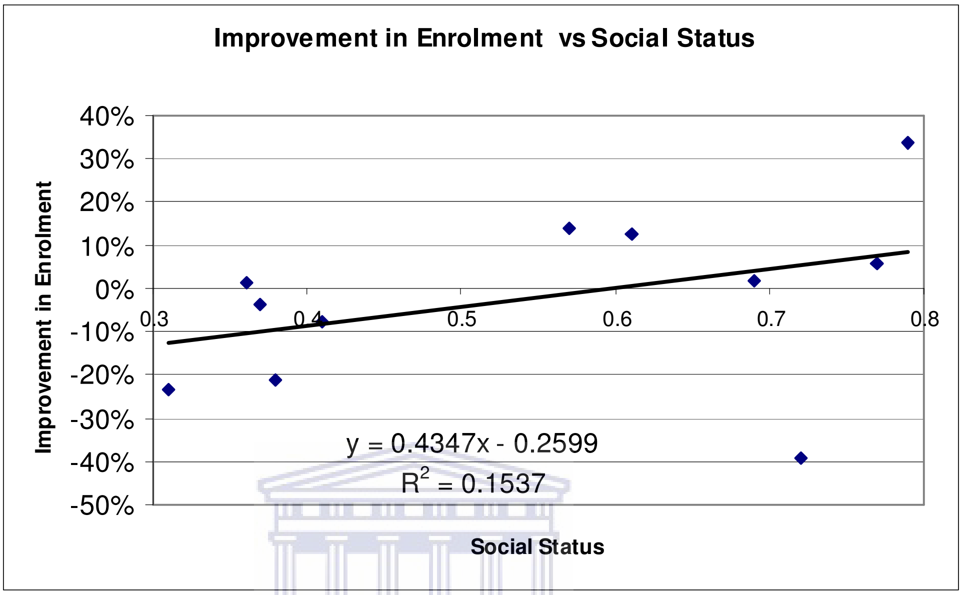


Figure 4.17

The improvement in Standard Grade Mathematics enrolment for the different social index in the first wave schools

In the second wave (Table 4.13), six of the eight schools in the LP quintile had an improved enrolment while five schools had an increase in pass rate. Ten of the eleven schools in quintile four had an improved enrolment with Luchoff having a substantial improvement of 68% and Zwartberg having a minimal decline of 5% in enrolment. All seven of the ten schools in quintile three had an improved enrolment and nine out of the ten schools had an increase in pass rate. All five schools in quintile two had an improvement in pass rate. All four schools in quintile one had an increased enrolment with Dysseldorp showing a substantial improvement of 84% while three of the four schools had an increase in pass rate.

Table 4.13

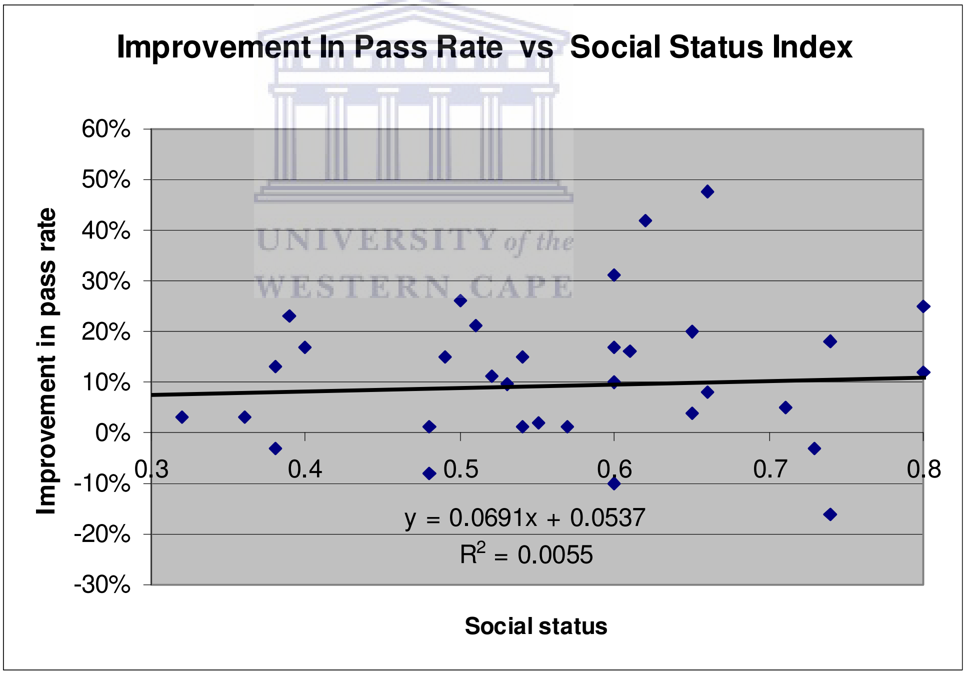
Standard Grade pass rates and enrolment figures for schools classified into social index for the second wave

School	Social Status	Quintiles	Improved Enrolment	Improved Enrolment	PreTech Enrol.	PostTech Enrol.	PreTech Pass Rate	PostTech Pass Rate	Improved Pass Rate
Oudtshoorn	0.27	LP	23%	38	146	184	94%	92%	-2%
Simons Town	0.29	LP	34%	35	85	120	82%	69%	-13%
Piketberg	0.32	LP	27%	15	48	63	97%	100%	3%
Grabouw	0.36	LP	-37%	-10	32	22	93%	96%	3%
Ladismith HS	0.38	LP	67%	25	25	50	94%	91%	-3%
Rylands	0.38	LP	-79%	-132	234	102	50%	63%	13%
Kensington	0.39	LP	9%	27	291	318	45%	68%	23%
Bernadino	0.4	LP	78%	174	135	309	37%	54%	17%
Westridge	0.48	4	61%	108	122	230	48%	40%	-8%
Zwartberg	0.48	4	-5%	-1	19	18	79%	80%	1%
Mondale	0.49	4	20%	70	318	388	67%	82%	15%
Wolseley	0.5	4	47%	23	37	60	58%	84%	26%
Luckhoff	0.51	4	68%	82	79	161	37%	58%	21%
Blackheath	0.52	4	54%	102	137	239	46%	57%	11%
Athlone	0.53	4	18%	52	261	313	46%	56%	10%
Atlantis	0.54	4	57%	91	115	206	57%	72%	15%
Steenberg	0.54	4	13%	36	267	303	44%	45%	1%
Proteus	0.55	4	28%	75	233	308	55%	57%	2%
Macassar	0.57	4	46%	48	80	128	25%	26%	1%
Groenberg	0.6	3	2%	2	118	120	38%	69%	31%
Kasselsvlei	0.6	3	15%	47	292	339	63%	80%	17%
Schoonspruit	0.6	3	64%	127	134	261	81%	70%	-10%
Symphony	0.6	3	50%	53	80	133	19%	29%	10%
Berg Rivier	0.61	3	21%	57	246	303	46%	62%	16%
Ladismith	0.62	3	19%	7	33	40	47%	89%	42%
Marian RC	0.65	3	-5%	-3	60	57	47%	51%	4%
Perseverance	0.65	3	-34%	-41	141	100	22%	42%	20%
Hawston	0.66	3	2%	1	43	44	24%	32%	8%
Pacaltsdorp	0.66	3	-59%	-117	258	141	38%	86%	48%
Brakrivier	0.71	2	53%	35	49	84	64%	69%	5%
Isilimela	0.71	2	22%	74	307	381	15%	20%	5%
New Orleans	0.73	2	41%	94	185	279	57%	54%	-3%
Emil Weder	0.74	2	63%	47	51	98	74%	58%	-16%
Houtbay	0.74	2	41%	32	63	95	25%	43%	18%
Sinethemba	0.8	1	37%	102	227	329	30%	55%	25%
Worcester	0.8	1	43%	36	66	102	63%	75%	12%
Dysseldorp	0.83	1	84%	38	26	64	71%	54%	-17%
Qhayiya	0.9	1	2%	2	86	88	30%	34%	4%

All of the social groupings showed similar results regarding the improvement in pass rate (Figure 4.18). In the regression analysis, the r^2 value is 0.0055, which is indicative of a very weak relationship between social status and improvement in pass rates. Almost 0% of the variation in the pass rates could be attributed to the social status.

Figure 4.18

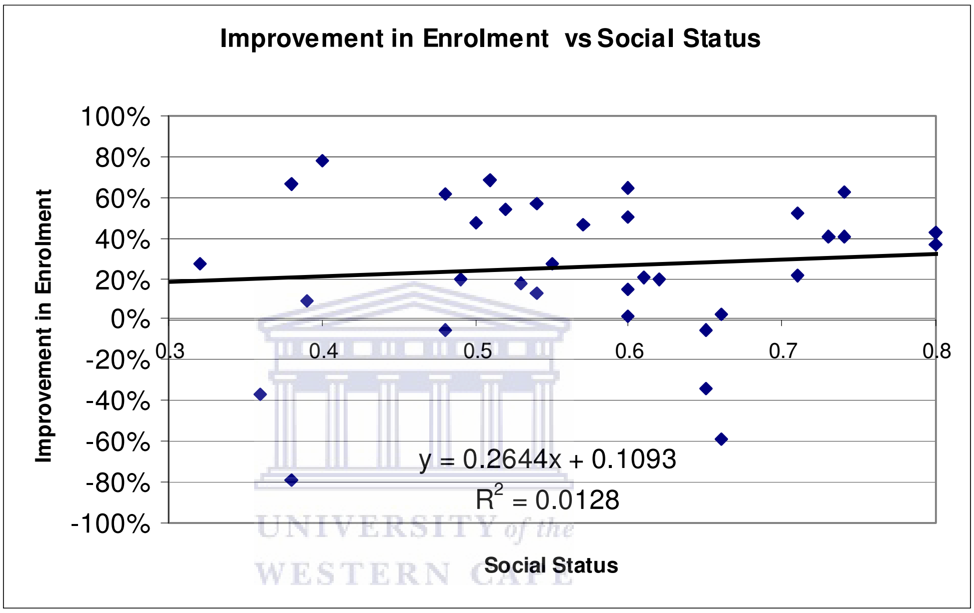
The improvement in Standard Grade Mathematics pass rate for the different social index in the second wave schools



There was a general increase in enrolment across the board for all categories of schools (Figure 4.19). The effect of the social status only accounted for 1% on the variation in improvement of enrolment figures. Therefore, in the second wave schools, there was a similar increase in pass rates and enrolment for the various social categories.

Figure 4.19

The improvement in Standard Grade Mathematics enrolment for the different social index in the second wave schools



In the LP quintile schools of the third wave, two of the three schools showed an increase in enrolment and pass rate (Table 4.14). All eight schools in the fourth quintile had an increase in enrolment and six of the schools' pass rate increased. Hundred percent of the quintile two schools had a substantial improvement in both enrolment and pass rate. Five of the six schools in quintile one had an increase in enrolment and pass rate.

Table 4.14

Standard Grade pass rates and enrolment figures for schools classified into social index for the third wave

School	Social Status	Quintiles	Improved Enrolment	Improved Enrolment	PreTech Enrol.	PostTech Enrol.	PreTech Pass Rate	PostTech Pass Rate	Improved Pass Rate
Bellville HTS	0.12	LP	11%	13	110	123	93%	100%	7%
Norman Henshil.	0.2	LP	-30%	-16	61	45	79%	76%	-3%
Gordon	0.36	LP	130%	26	7	33	49%	57%	8%
Belgravia	0.44	4	47%	35	57	92	61%	67%	6%
Cravenby	0.48	4	9%	3	31	34	77%	62%	-15%
Grassy Park	0.49	4	15%	5	30	35	47%	49%	2%
Malibu	0.52	4	54%	17	23	40	43%	66%	23%
Lotus Sec	0.55	4	200%	1	0	1	24%	57%	33%
Strandfontein	0.55	4	200%	14	0	14	39%	36%	-3%
Zandvliet	0.55	4	67%	2	2	4	45%	59%	14%
Spine Road	0.56	4	38%	7	15	22	54%	55%	1%
Saxonsea	0.62	3	-40%	-1	3	2	28%	54%	26%
Modderdam	0.64	3	200%	2	0	2	34%	36%	2%
Sophumelela	0.7	2	163%	26	3	29	34%	65%	31%
Bulumko	0.76	2	129%	18	5	23	29%	67%	38%
Masiyile	0.77	2	136%	17	4	21	27%	42%	15%
Chris Hani	0.79	1	- 111%	-5	7	2	35%	67%	32%
Kwamfundo	0.79	1	167%	20	2	22	29%	30%	1%
Kylemore	0.79	1	100%	8	4	12	48%	43%	-5%
Matthew Goniwe	0.8	1	200%	23	0	23	35%	43%	8%
Indwe	0.82	1	200%	5	0	5	25%	59%	34%
Percy Madala	0.82	1	120%	9	3	12	38%	71%	33%

Only four of the twenty two schools had a decline in the pass rate therefore 82% of the schools had an increase in the Mathematics pass rate after integrating technology in Mathematics education (Figure 4.20). There was a general increase in pass rates for all of the social groupings. Social status accounted for 18% of the variation in improvement in pass rate.

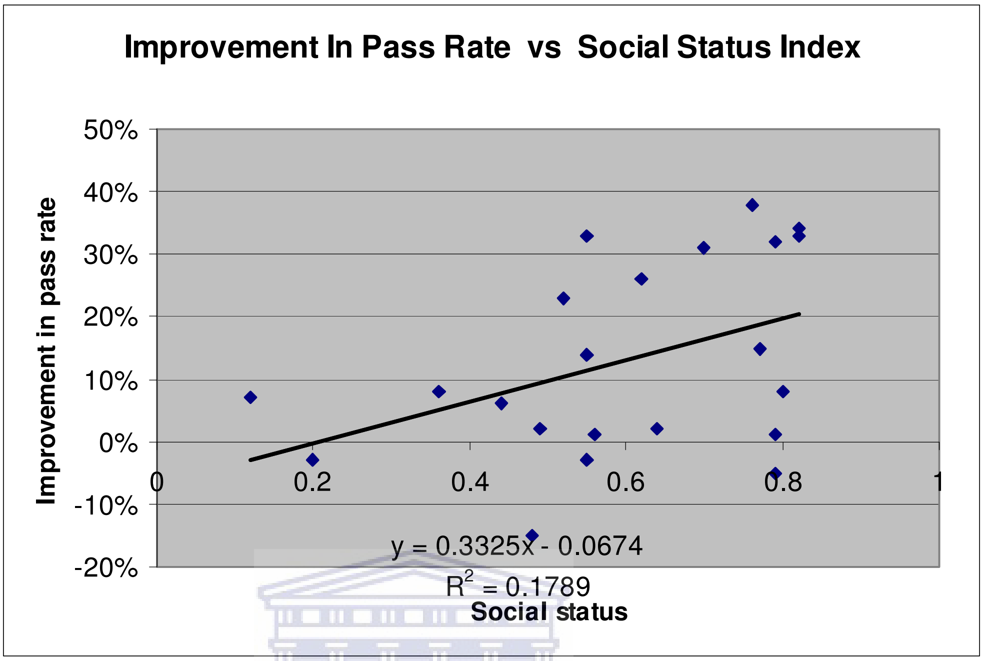


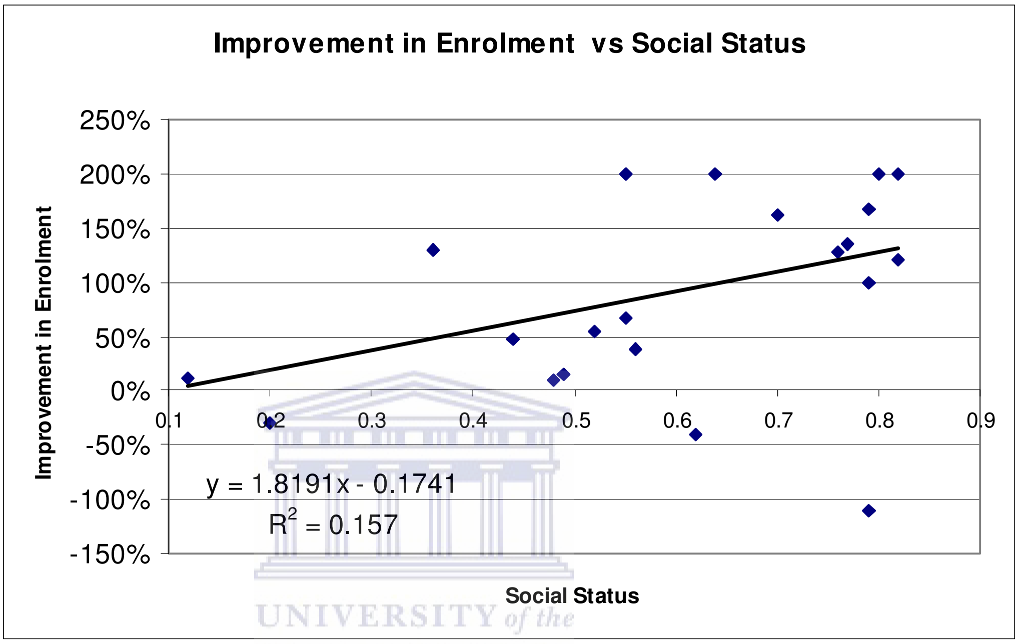
Figure 4.20

The improvement in Standard Grade Mathematics pass rate for the different social index in the third wave schools

Nineteen of the twenty two schools had an increase in enrolment figures after technology infusion (Figure 4.21). Five of the disadvantaged schools had increases of up to 200%, but in the regression analysis, the r^2 value of 0.157 indicates a weak relationship. Social status accounted for 16% of the variation in enrolment.

Figure 4.21

The improvement in Standard Grade Mathematics enrolment for the different social index in the third wave schools



4.5. Summary of Findings

4.5.1 Stage One Summary: Higher Grade

Stage one was a longitudinal study of the matric exam results from the year 1999 to 2005. The matric standardised Mathematics scores were compared for the periods of pre-IT implementation, year of implementation and post-IT implementation. The pass rate in the Mathematics Higher Grade examinations for the pre-IT years was 69% and this dropped by 1% in the year of implementation to 68%. Therefore there was no significant change in the examination score for the year of implementation. This could be attributed to the fact that learners had just started using technology in Mathematics for the first time so no significant difference was expected in the pass rate. The pass rate increased by 3% for the post-IT years with a p-value of 0.35 indicating that the increase in pass rate was not significant. The probability exists that the increase in pass rates is not reliable due to the fact that schools varied regarding the number of years of pre-IT compared to the number of years of post-IT.

4.5.2 Stage One Summary: Standard Grade

The Mathematics Standard Grade pass rate increased by 7.97% in the year of IT implementation and then by another 3.06% for the post-IT year. Therefore there was a net increase of 11.03% in the pass rate with an associated p-value of 0.0001 indicating that the increase was significant. Although the increase was significant, this analysis could also be considered to be not totally reliable since this was a composite analysis of all the Standard Grade scores independent of the variations among schools for the pre-IT and the post-IT years and other co-variates.

4.5.3 Stage Two Summary: Higher Grade

In stage two, the results from each wave of school was analysed. Individual waves comprised of schools that had similar number of pre-It and post-IT years. Therefore a relatively valid analysis could be undertaken. In the pilot wave, six out of eight schools had an increase in pass rate in the Mathematics Higher Grade examinations for the post-IT years. The average increase in pass rate was 5%. In the second wave, seventeen out of twenty three schools had an increase in pass rate. Individual schools varied in pass rate in the range of 2% to 48%. These results correlate with the literature reviewed that provides evidence of an increase in pass rate in schools that use ICT in education as compared to using traditional teaching methods. Variations in pass rate could be explained by the amount of time learners spend using ICT for Mathematics education. The literature informs that learners, who used the tools of ICT in Mathematics lessons more frequently, outperformed the lower end users of ICT. A limitation of this research is that observing learners using computers in education and recording results would have provided data regarding how technology was used and how much time was spent in Mathematics using technology.

In the third wave, only four out of twelve schools showed an increase in pass rate. Besides two schools, most of the schools had a small decrease in pass rates ranging from 1% to 5%. A probable explanation could be the third wave schools received computer labs at a later stage compared to the first and second waves and were therefore still in the process of adopting the new education paradigm.

4.5.4 Stage Two Summary: Standard Grade

ICT had a stronger impact on the Standard Grade pass rate than the Higher Grade pass rate of stage two. The results of the pilot wave show that there was a 14% increase in the pass rate of schools for the year ICT was integrated in Mathematics education. Thereafter, the pass rate stabilised in the sixty percent range with 2005 having a lower end pass rate of 61%. Wave two had a slightly higher average pass rate for the post IT years compared to the pre-IT years. Results in the third wave indicate a consistent increase in pass rates for the pre-IT years. The increase in pass rate continued for the post IT years with the exception in 2005 where there was a decline in pass rate. The fourth wave reflected a similar pattern to the third wave; a steady increase in pass rate and a drop in the pass rate in the year 2005. The decline in the pass rate for the year 2005 could be attributed to higher standards of examinations for that year.

Although there was an increase in the pass rates for the post IT years in most of the waves, it is not conclusive that ICT was responsible for the improvement in pass rate since there was also an increase in the pre-IT years.

4.5.5 Stage Three Summary: Higher Grade

Stage three examined results from schools of different socio-economic backgrounds. The varying classes of schools were investigated regarding the pass rate and enrolment figures for pre-IT and post-IT.

There was a general improvement in the pass rate and enrolment for the relatively affluent schools (quintile LP and quintile 4) in the first wave Higher Grade schools (Table 4.10). The second wave schools also showed an overall improvement in the pass rate and enrolment (Table 4.11). In the third wave schools, there was a strong increase in the enrolment for most schools from all socio-economic status backgrounds.

4.5.6 Stage Three Summary: Standard Grade

All categories of schools had an increase in pass rate but the enrolment figures varied in the first wave Standard Grade results (Table 4.13). The second wave schools from all socio-economic backgrounds had an increase in pass rate and enrolment (Table 4.14). The third wave schools also showed an increase in pass rate and enrolment for all categories of schools. The fact that social status generally had a minimal influence on the pass rate as compared to technology indicates that technology in Mathematics education had an impact on learner performance.

Chapter Five

5. Conclusion and Recommendations

5.1 Introduction

The aim of this research is to provide insight into the integration and implications of ICT in Mathematics education in high schools of the Western Cape. Educationists believe that there is an inherent beneficial potential in technology while sceptics caution that there is inadequate evidence to support that technology impacts positively on the teaching learning process (Bergh, 2002). The adoption of ICT in education is steadily increasing (Green, 2002) and the traditional methods of education are being modified and transformed by technological innovations (Daigle & Jarmon, 1997, Sun Microsystems, 2002). As a result of a lack of available research conducted in the field of ICT integration in education in South African schools, the research report aims to overcome this by providing detailed statistical data regarding learner performance in Mathematics prior to using computers in Mathematics education and after utilising technology for curriculum delivery in Mathematics lessons. This research encompasses a quantitative study of the standardised Mathematics examination scores in grade twelve prior to ICT and post-IT, to test the validity of the hypothesis: Computer integration in Mathematics education for curriculum delivery enhances learner performance. Data was statistically analysed at three levels, which are referred to as stage one, stage two and stage three, in an attempt to conduct a comprehensive study of technology integration in mathematics education.

5.2 Conclusion: Higher Grade

The composite analysis of the Mathematics Higher Grade results in stage one reflects a minimal increase of 3% in the pass rate for the Post-IT years. This increase is insignificant due to a p-value of 0.35. The findings in stage two show a more positive effect of ICT in Mathematics education. In the pilot wave, six of the eight schools had an increase in pass rates for the Post-IT years while seventeen of the twenty three schools in the second wave had an increase in pass rate for the Post-IT years. Variations in the pass rates range from 2 % to 48 %. In the third wave, only four of the twelve schools had increases in pass rates. The findings in stage three reflect a general increase in pass rates and enrolment figures, although the pass rates and enrolment figures declined in some schools.

5.3 Conclusion: Standard Grade

In stage one, the mathematics Standard Grade pass rate increased by 11.03 % in the Post-IT years with a p-value of 0.0001 which is indicative of a significant increase in pass rate. There is an overall significant increase in pass rate for the Standard Grade examination compared to the Higher Grade examination in the Post-IT years, however the Standard Grade pass rate also declined at times, especially in the year 2005. In the findings of stage three, there was a general increase in the pass rate and enrolment of learners in Mathematics for schools from various socio-economic backgrounds. However, just as in the Higher Grade results, the findings were inconsistent since some schools showed no increase while some of the schools had a drop in pass rates and enrolment for the Post-IT years.

Although the evidence of the impact of ICT in Mathematics education is not consistent across all of the schools, greater technology access resulted in an increase in the standardised Mathematics scores in many of the schools, however some of increases were insignificant. This correlates with the literature surveyed where findings indicate that ICT can at times improve outcomes in Mathematics, although individual effects are often weak and findings are inconsistent (Kulik, 2003). A quantitative analysis of standardised examination scores in sixteen studies in the USA established that Mathematics standardised test scores are at least slightly higher in the group of learners that used ICT in Mathematics education. In the literature reviewed, findings in the UK state that learners who used technology in Mathematics education more frequently, performed better than those learners who used technology to a lesser extent. Nine of the sixteen studies reflected a statistically significant difference in results post-technology. Studies in Europe emphasise that the enormous investment in ICT at schools do not correlate with the level of integration in curriculum delivery. There are cases when there is a positive association between ICT and learner achievement but it is not statistically significant. This lack of statistical significance could imply that learners' use of ICT in Mathematics has no effect on their performance, however, studies in England (BECTA, 2003) state that those considerations of differences in practice such as:

- How ICT is applied
- How frequency is ICT used and
- How ICT is managed and implemented

need to be explored, to fully understand the findings.

5.4 Recommendations for further study

Further research in the field of technology integration in education to investigate why some schools continue to perform poorly after technology is used as a tool in the education process should provide a clearer understanding of the findings. Many academics claim that an impact study of a project yields stronger results if the project has been in existence for a prolonged period of time. Further research in ICT in education, especially the Khanya Project over a longer period of time should provide more substantial results. Longitudinal studies that chart the progress of the same learners over an extended time period could produce a stronger set of results. A qualitative study to determine the attitudes, perceptions and confidence of learners and educators in ICT integration will provide a more holistic view of technology in education. Studies could be conducted to establish if interactive multimedia software, pivotal to curriculum delivery, motivates learners and leads to improved performance. Studies in England favour action research. This type of research will allow researchers to study and observe educators and learners over a period of time in the teaching/learning process, interacting with technology. Action research could also explore the frequency of ICT usage on learner attainment, since global study findings indicate that in some countries where the infrastructure is in place, the technology is not used to its full potential.

5.5 Recommendations for Policy Implications

The government's white paper on e-Education (e-Education, 2004) states that schools should be characterised as institutions that have:

- learners who utilise ICT to enhance learning;
- qualified and competent teachers who use ICT to enhance teaching and learning; and
- access to ICT resources that support curriculum delivery.

The South African government set up a body called the Presidential International Advisory Council on Information Society and Development (PIAC on ISAD). The Council consists of Chief Executive Officers from major international corporations and experts active in the field of information and communication technology. The role of the Advisory Council is to advise Government on addressing the issue of ICT, especially in education. This study can be a source to inform government of how ICT is integrated globally and infusing ICT for curriculum delivery. Various Provinces have notably effected ICT integration in education at differing levels. The Western Cape Education Department leads the way in ICT integration (e-Education, 2004). This study can serve to inform the other provinces on successful ICT integration and implementation. The Western Cape Education Department and the Khanya Project management have requested a copy of this study as an assessment of the impact of ICT in Mathematics education.

Education through the use of ICT is a powerful means of supporting learners to achieve the nationally-stated curriculum goals. ICT in the teaching/learning process encourages:

- learner-centred learning;
- active, exploratory, inquiry-based learning;
- collaborative work among learners and teachers; and
- analytical skills and critical thinking.

The literature reviewed reflects that one of the challenges in successfully implemented e-Learning, is the confidence levels of educators in using computers for curriculum delivery. The education department in South Africa should view this as priority in providing support for educators using technology. It is essential that a module on ICT in education is contained in the curriculum of university undergraduate education programmes; to prepare future educators how to incorporate technology in the classroom to enhance the teaching/learning process.

6. Bibliography

Babbie, E. & Mouton, J. 2001. The Practice of Social Research. Oxford: Oxford University Press.

Becker, H. J. 1992. Computer-Based Integrated Learning Systems in the Elementary and Middle Grades: A Critical Review and Synthesis of Evaluation Reports. Journal of Educational Computing Research, 8(1):1-41.

Becta. (2005). The impact of technology in education. [Online]. Available: http://www.becta.org.uk/research/research.cfm?section=1&id=536 [23 September 2006].

BECTA. 2005. Annual Report: Executive Summary-ICT test bed evaluation. [Online]. Available: http://www.evaluation.icttestbed.org.uk/reports/2005/summary.html [13 August 2006].

BECTA. 2005. ICT in Learning and Teaching. [Online]. Available: http://www.evaluation.icttestbed.org.uk.html [13 August 2006].

BECTA. 2006. Pupil learning and attainment. [Online]. Available: http://www.becta.org.uk/research/research.cfm?section=1&id=432 [23 January 2007].

Bergh, L. 2002. The impact of ICTs in education: attitudes and perceptions of secondary school learners to ICTs in South African schools. Cape Town. UCT. (Honours thesis.)

Bottino, R. M. 2004. The evolution of ICT-based learning environments: which perspectives for the school of the future? British Journal of Educational Technology, 35(5): 553-567.

Bottino, R. M., Forcheri, P. & Molfino, M. T. 2000. Technology transfer in schools: From research to innovation, 29(2): 163-172.

Burns, R. 2000. Introduction to Research. 4th edition.London. Sage Publications.

Centre for Applied Research in Educational Technology. 2005. How can technology influence student academic performance? [Online]. Available: http://caret.iste.org/index.cfm?fuseaction=answer&questionID=1 [12 December 2006]

CETDE. (2003). Report on the visit by CETDE to the UK. Centre for Educational Technology and Distance learning. [Online]. Available:
http://education.pwv.gov.za/ten2UK/820NGfl/820Tour.html
[12 July 2005].

Conlon, T. & Simpson, M. 2003. Silicon Valley versus Silicon Glen: The impact of computers upon teaching and learning: a comparative study. British Journal of Educational Technology, 34(2): 137-150.

Console, G., Dyke, M., Oliver, M. & Seale, J. 2004. Mapping pedagogy and tools for effective learning design. Computers & Education, 43(1): 17-33.

Cox, M. 2005. ICT and Attainment: A review of the research literature. London: Becta.

Daigle, S.L. & Jarmon, C.G. 1997. Building the Campus Infrastructure that really counts. [Online]. Available:
http://www.educase.edu/pub/er/review.html
[12 July 2006].

Department of Education. 2003. White Paper on e-education. Pretoria. Department of Education.

Dickard, N. 2003. Computing Technologies in school education. [Online]. Available:
www.aare.edu.au/05pap/moy05461.pdf
[30 October 2004].

Dwyer, D. 1994. Apple classrooms of tomorrow. What we've learned. Educational leadership, 51:4-10.

Easton, V.J., 2005. Research Sampling. [Online]. Available:
http://www.stat.yale.edu/Courses/1997-98/101/sample.html.
[25 September 2006].

E-Education, 2004. White Paper on E-Education: Transforming Learning and Teaching through ICT. [Online]. Available:
http://www.stat.yale.edu/Courses/1997-98/101/sample.html.
[02 April 2006].

Ercikan, K. 2005. Quantitative Research. [Online]. Available:
http://www.aera.net/uploadedFiles/Publications/Journals/Educational_Researcher/3505_Ercikan.pdf
[12 March 2007].

Green, K. 2002. Technology and Instruction. [Online]. Available: http://www.campuscomputing.net/archive/tech and instruction.pdf
[26 July 2005].

Groebner, D.F. & Shannon, P.W. 1981. Business Statistics: a decision-making approach. 3rd edition. Ohio: Merrill Publishing Company.

Hardman, J. 2005. Activity Theory as a framework for understanding teachers' perceptions of computer usage at a primary school level in South Africa. South African Journal of Education, 25(4): 258-265.

Hardman, J. 2005. An exploratory case study of computer use in a primary school Mathematics classroom: new technology, new pedagogy? Perspectives in education, 23(4): 1-13.

Hennessy, H., Ruthven, K. & Brindley, S. 2005. Teacher perspectives on integrating ICT into subject teaching: commitment, constraints, caution and change. Faculty of Education. University of Cambridge.

Hokanson, B. & Hooper, S. 2005. Computers as cognitive media: examining the potential of computers in education. Computers in Human Behaviour, 16(5):537-552.

Howell, C. & Lundall, P. 2000. Computers in schools: a national survey of Information Communication Technology in South African schools. Cape Town. EPU University of the Western Cape.

HSRC. 2005. Mathematics Results: International Study. [Online]. Available: http://www.hsrc.ac.za/Document-230.phtml
[02 June 2005].

ICAAP. 2004. Resources for methods in evaluation and social research. [Online]. Available: http://gsociology.icaap.org/methods.html.
[14 May 2004].

Ilomaki, L. & Rantanen, P. 2005. Intensive use of ICT in school: developing differences in students' ICT expertise. Computers & Education, 48(1): 119-136.

Jonassen, D. H. 1996. Computers in the classroom: Mindtools for critical thinking. New Jersey: Prentice-Hall.

Keller, G. & Warrack, B. 1999. Statistics for management and economics. 5th edition. USA: Duxbury.

Khanya (2002). Technology in Education Business Plan. Cape Town. Department of Education (WCED).

Kulik, J.A. 2003. Effects of Using Instructional Technology in Elementary and Secondary Schools: What Controlled Evaluation Studies Say. [Online]. Available: http://www.sri.com/policy/csted/reports/sandt/it
[21 March 2007].

Lim, C. P. 2002. A theoretical framework for the study of ICT in schools: a proposal. British Journal of Educational Technology, 33(4): 411-421.

Louw, L. & Muller, J. 2004. Learner performance and mastermaths: Khanya evaluation project. Cape Town. UCT.

Mouton, J. 1996. Understanding social research. Pretoria: Van Schaik.

Mouton, M. 2001. How to succeed in your master's & doctoral Studies: a South African guide and resource book. Pretoria: Van Schaik.

Neuman, L.W. 2000. Social Research Methods: qualitative and quantitative approaches. USA: Allyn & Bacon.

Nichol, J. & Watson, K. 2003. Editorial: Rhetoric and reality-the present and future of ICT in education. British Journal of Educational Technology, 34(2): 131-136.

OECD. 2000. Information and Communication Technology and the quality of learning. Paris: CERI.

OECD. 2000. Programme for International Student Assessment (PISA). [Online]. Available: http://www.pisa.oecd.org/document/50/0,en3343.html
[07 October 2004].

OECD. 2001. Programme for International Student Assessment (PISA). [Online]. Available: http://www.pisa.oecd.org/pages/0,2987,en_32252351_33351545_.html
[02 September 2006].

OECD. 2004. Programme for International Student Assessment (PISA). [Online]. Available: http://www.pisa.oecd.org/pages/0,2987,en_32252351_32235731_.html
[20 June 2006].

OECD. 2005. Programme for International Student Assessment (PISA). [Online]. Available: http://www.pisa.oecd.org/pages/0,2987,_32252351_34532465_.html
[23 November 2006].

Patrick, J. 2002. Using ICT in Education. [Online]. Available: http://www.adb.org/Documents/Reports/ICT-Education-Training/default.asp
[23 July 2004].

Presland, A. & Wilshart, J. 2004. Secondary school pupils' motivations to use an Integrated Learning System. British Journal of Educational Technology, 35(5): 663-668.

Rogers, L. 2002. Learning science with ICT: how do teachers make a difference? The Centre Seminar Series on the Relationship between ICT and Specific Subject Disciplines. Coventry.

Rourke, L & Anderson, T. 2004. Validity in Quantitative content analysis. Educational technology research & Development, 52(1): 5-18.

Russel, D. & Schneiderheinze, A. 2005. Understanding Innovation in Education using Activity Theory. Educational Technology & Society, 8:38-53.

Sayed, Y. 1998. The Segregated Information Highway: information literacy in Higher Education. Cape Town. University of Cape Town Press.

Smith, C. 2005. The state of Mathematics in schools. [Online]. Available: http://curriculum.pgwc.gov.za/site/46/news/view/810
[28 November 2005].

Strydom, W.S., Thomson, J. & Williams, C.H. 2005. Understanding ICT integration in South African classrooms. Perspectives in education, 23(4): 71-83.

Sugar, W., Crawley, F. & Fine, B. 2005. Critiquing Theory of Planned Behaviour as a method to assess teachers' technology integration attitudes. British Journal of Educational Technology, 36(2): 331-334.

Sun Microsystems. 2002. Sun TM One in education. [Online]. Available: http://www.sun.com/products/edu/download/SunOne_in_education.pdf
[27 July 2004].

TIMSS. 2003. Trends in International Mathematics and Science Study. [Online]. Available: http://timss.bc.edu/timss2003i/intl_reports.html
[14 March 2005].

Zille, H. 2001. WCED launches initiatives to boost Maths Results. Cape Town. Western Cape Education Department.

APPENDIX I

REQUEST TO CONDUCT RESEARCH AT SCHOOLS IN THE WESTERN CAPE EDUCATION DEPARTMENT (WCED)

Dear Sir

I, Indren Govender hereby apply for approval to conduct research in public schools within the Western Cape Education Department. I am an educator at Rylands high school and also currently doing a masters degree in information management at UWC.

My research involves evaluating the Khanya Project. A project initiated by WCED, exploring the integration of ICT in schools for curriculum delivery. One of Khanya's primary goals was to integrate ICT in Mathematics education to enhance learner performance. My research encompasses doing a statistical analysis of matric Mathematics results to determine the impact that ICT has on learner results. I will be using the quantitative research methodology, conducting a statistical analysis of matric Mathematics results before and after using ICT in Mathematics lessons. I have the full support of the head of the Khanya project, Mr Kobus van Wyk, who is keen to examine the findings of my study since it could contribute towards the sustainability of the Khanya project.

Thank you for your assistance.

Yours faithfully
I. Govender

APPENDIX II

<u>Letter of approval from Dr. R. Cornelissen: Head of research (WCED) to conduct research at schools.</u>

Dear Mr I. Govender

<u>RESEARCH PROPOSAL: THE INTEGRATION OF ICT IN EDUCATION TO IMPROVE MATHEMATICS RESULTS</u>.

Your application to conduct the above-mentioned research in schools in the Western Cape has been approved subject to the following conditions:

1. Principals, educators and learners are under no obligation to assist you in your investigation.
2. Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3. You make all the arrangements concerning your investigation.
4. The programmes of educators are not to be interrupted.
5. No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December 2006).
6. Should you wish to extend the period of your survey, please contact Dr R. Cornelissen at the contact numbers above quoting the reference number.
7. A photocopy of this letter is submitted to the Principal where the intended research is to be conducted.
8. Your research will be limited to the list of following schools as submitted to the Western Cape Education Department.
9. A brief summary of the content, findings and recommendations is provided to the Director: Education Research.
10. The Department receives a copy of the completed report/dissertation/thesis addressed to:

    The Director: Education Research
    Western Cape Education Department
    Private Bag X9114
    CAPE TOWN
    8000

We wish you success in your research.

Kind regards.

Signed: Ronald S. Cornelissen
for: **HEAD: EDUCATION**
DATE: 28th August 2006

APPENDIX III

The SAS System: Analysis of Stage One

(HG)

15:27 Monday, October 23, 2006 1

The FREQ Procedure

Table of implement by math

implement math

Frequency / Percent / Row Pct	Failed	Passed	Total
Pre IT	12736	11608	24344
	27.14	24.74	51.88
	52.32	47.68	
Year IT	3639	4494	8133
	7.75	9.58	17.33
	44.74	55.26	
Post IT	5933	8517	14450
	12.64	18.15	30.79
	41.06	58.94	
Total	22308	24619	46927
	47.54	52.46	100.00

The SAS System
15:27 Monday, October 23, 2006 2

grade=HG

The FREQ Procedure

Table of implement by math

implement math

Frequency / Percent / Row Pct	Failed	Passed	Total
Pre IT	534	1215	1749
	11.90	27.08	38.98
	30.53	69.47	

Year IT	244 5.44 32.23	513 11.43 67.77	757 16.87
Post IT	575 12.81 29.03	1406 31.33 70.97	1981 44.15
Total	1353 30.15	3134 69.85	4487 100.00

The SAS System: Analysis of Stage One (SG)

The SAS System
15:27 Monday, October 23, 2006 3

grade=SG

The FREQ Procedure

Table of implement by math

implement math

Frequency Percent Row Pct	Failed	Passed	Total
Pre IT	12202 28.75 54.00	10393 24.49 46.00	22595 53.24
Year IT	3395 8.00 46.03	3981 9.38 53.97	7376 17.38
Post IT	5358 12.62 42.97	7111 16.76 57.03	12469 29.38
Total	20955 49.38	21485 50.62	42440 100.00

The SAS System
15:27 Monday, October 23, 2006 4

grade=HG

The FREQ Procedure

Summary Statistics for implement by math
Controlling for id

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)

Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	2.0944	0.1478
2	Row Mean Scores Differ	2	2.1168	0.3470
3	General Association	2	2.1168	0.3470

Total Sample Size = 4487

The SAS System
15:27 Monday, October 23, 2006 5

grade=SG

The FREQ Procedure

Summary Statistics for implement by math
Controlling for id

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)

Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	236.5979	<.0001
2	Row Mean Scores Differ	2	277.7383	<.0001
3	General Association	2	277.7383	<.0001

Total Sample Size = 42440

Additional results based on GENMOD analysis with repeated observations on school ID. This gives an estimate that takes into account the dependency of observations within the same school. The estimated proportion of those who pass is given. The results agree with the CMH analysis with p-values of similar magnitudes.

Percent Passing at each School at each Stage of Implementation
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Obs	implement	grade	p
1	Pre IT	HG	0.64294
2	Year IT	HG	0.60310
3	Post IT	HG	0.65869

Percent Passing at each School at each Stage of Implementation
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Obs	implement	grade	p
391	Pre IT	SG	0.45288
392	Year IT	SG	0.52782
393	Post IT	SG	0.53995

Percent Passing at each School at each Stage of Implementation
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grade=SG

The GENMOD Procedure

Analysis Of GEE Parameter Estimates
Empirical Standard Error Estimates

Parameter	Estimate	Standard Error	95% Confidence Limits	Z	Pr > |Z|

Intercept	0.1114	0.0841	-0.0534	0.2762	1.32	0.1853
implement Post IT	0.0488	0.0579	-0.0648	0.1623	0.84	0.3999
implement Pre IT	-0.3004	0.0574	-0.4129	-0.1879	-5.23	<.0001
implement Year IT	0.0000	0.0000	0.0000	0.0000	.	.

Score Statistics For Type 3 GEE Analysis

Source	DF	Chi-Square	Pr > ChiSq
implement	2	26.33	<.0001

Least Squares Means

Effect	implement	Estimate	Standard Error	DF	Chi-Square	Pr > ChiSq
implement	Post IT	0.1602	0.0862	1	3.45	0.0631
implement	Pre IT	-0.1890	0.0752	1	6.32	0.0120
implement	Year IT	0.1114	0.0841	1	1.75	0.1853

Differences of Least Squares Means

Effect	implement	_implement	Estimate	Standard Error	DF	Chi-Square	Pr > ChiSq
implement	Post IT	Pre IT	0.3492	0.0615	1	32.23	<.0001
implement	Post IT	Year IT	0.0488	0.0579	1	0.71	0.3999
implement	Pre IT	Year IT	-0.3004	0.0574	1	27.40	<.0001

Percent Passing at each School at each Stage of Implementation
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grade=HG

The GENMOD Procedure

Analysis Of GEE Parameter Estimates
Empirical Standard Error Estimates

Parameter	Estimate	Standard Error	95% Confidence Limits		Z	Pr > |Z|
Intercept	0.4184	0.2253	-0.0232	0.8600	1.86	0.0633
implement Post IT	0.2391	0.1520	-0.0589	0.5370	1.57	0.1158
implement Pre IT	0.1698	0.1311	-0.0872	0.4267	1.30	0.1953
implement Year IT	0.0000	0.0000	0.0000	0.0000	.	.

Score Statistics For Type 3 GEE Analysis

Source	DF	Chi-Square	Pr > ChiSq
implement	2	1.54	0.4628

Least Squares Means

Effect	implement	Estimate	Standard Error	DF	Chi-Square	Pr > ChiSq
implement	Post IT	0.6575	0.1915	1	11.78	0.0006
implement	Pre IT	0.5882	0.2044	1	8.28	0.0040
implement	Year IT	0.4184	0.2253	1	3.45	0.0633

Differences of Least Squares Means

Effect	implement	_implement	Estimate	Standard Error	DF	Chi-Square	Pr > ChiSq
implement	Post IT	Pre IT	0.0693	0.1154	1	0.36	0.5481
implement	Post IT	Year IT	0.2391	0.1520	1	2.47	0.1158
implement	Pre IT	Year IT	0.1698	0.1311	1	1.68	0.1953

APPENDIX IV

KHANYA MATHEMATICS HG PROJECT: STAGE 2 DATA

First Wave Higher Grade Pass rate for Pre-IT and Post-IT						
SCHOOL	**YEAR AND %**	**% Pass**	**Passed**	**Maths HG enrolment**	**PreTech**	**PostTech**
Bridgton	1999	100	7	7		
2001/08/01	2000	80	4	5	90%	75%
	2001	88	7	8	20	18
	2002	100	3	3	16	12
	2003	0	0	0		
	2004	100	4	4		
	2005	56	5	9		
Garlandale	**1999**	**64**	**7**	**11**		
2001/08/01	2000	83	10	12	76%	78%
	2001	79	11	14	37	28
	2002	93	13	14	55	43
	2003	79	11	14		
	2004	69	9	13		
	2005	71	10	14		
Harold Cressy	1999	46	24	52		
2001/08/01	2000	26	18	68	39%	45%
	2001	53	21	40	160	63
	2002	31	19	62	178	80
	2003	36	19	53		
	2004	76	22	29		
	2005	59	20	34		
Klein Nederburg	1999	54	7	13		
2001/08/01	2000	27	3	11	39%	45%
	2001	33	3	9	33	13
	2002	63	10	16	65	29
	2003	64	9	14		
	2004	16	3	19		
	2005	44	7	16		
Livingstone	1999	100	41	41		
2001/08/01	2000	98	65	66	99%	98%
	2001	100	42	42	149	148
	2002	96	48	50	243	238
	2003	100	54	54		
	2004	96	72	75		

	2005	100	64	64		
Luhlaza	1999	18	2	11		
2001/08/01	2000	60	3	5	43%	84%
	2001	71	5	7	23	10
	2002	89	8	9	25	21
	2003	75	3	4		
	2004	83	10	12		
	2005	0	0	0		
Sarepta	1999	64	7	11		
2001/08/01	2000	63	5	8	59%	61%
	2001	53	8	15	34	20
	2002	80	4	5	66	40
	2003	71	15	21		
	2004	100	10	10		
	2005	37	11	30		
South Penninsula	1999	86	18	21		
2001/08/01	2000	93	13	14	92%	93%
	2001	100	13	13	48	44
	2002	91	20	22	122	114
	2003	96	23	24		
	2004	85	23	27		
	2005	98	48	49		
TOTAL	1999	68	116	171		
	2000	64	123	191	68%	73%
	2001	74	113	152	514	352
	2002	69	132	192	840	614
	2003	73	141	194		
	2004	75	163	218		
	2005	75	178	236		
PERCENTAGE	1999		67.84%			
	2000		64.40%			
	2001		74.34%			
	2002		68.75%			
	2003		72.68%			
	2004		74.77%			
	2005		75.42%			
WCED	2002		89.30%			
	2003		88,57%			
	2004		83,8%			
	2005		86,58%			

Second Wave Higher Grade Pass rate for Pre-IT and Post-IT						
SCHOOL	YEAR	% Pass	Passed	Maths HG enrolment		
Atlantis	1999	75	3	4		
2002/04/12	2000	60	3	5	73%	88%
	2001	100	2	2	11	8
	2002	100	5	5	33	29
	2003	100	4	4		
	2004	82	9	11		
	2005	85	11	13		
Berg Rivier	1999	0	0	6		
2002/05/30	2000	67	2	3	22%	57%
	2001	0	0	0	9	2
	2002	67	2	3	21	12
	2003	67	2	3		
	2004	60	3	5		2
	2005	50	5	10		12
Bernadino Heights	1999	100	2	2		
2002/04/24	2000	60	3	5	60%	46%
	2001	33	1	3	10	6
	2002	31	4	13	37	17
	2003	40	2	5		
	2004	60	6	10		
	2005	56	5	9		
Blackheath	1999	0	0	2		
2002/05/10	2000	100	1	1	67%	65%
	2001	100	3	3	6	4
	2002	86	6	7	17	11
	2003	100	1	1		
	2004	17	1	6		
	2005	100	3	3		
COSAT	1999	0	0	0		
2002/03/09	2000	0	0	0	77%	91%
	2001	77	10	13	13	10
	2002	95	21	22	106	96
	2003	100	21	21		
	2004	89	32	36		
	2005	81	22	27		
Grabouw	1999	0	0	0		
2002/04/19	2000	100	8	8	100%	95%
	2001	100	5	5	13	13
	2002	100	3	3	21	20
	2003	86	6	7		

	2004	100	6	6		
	2005	100	5	5		
Groenberg	1999	100	3	3		
2002/03/11	2000	25	1	4	63%	67%
	2001	100	1	1	8	5
	2002	100	3	3	9	6
	2003	100	1	1		
	2004	33	1	3		
	2005	50	1	2		
Kasselsvlei	1999	57	4	7		
2002/04/24	2000	100	9	9	88%	63%
	2001	100	8	8	24	21
	2002	67	6	9	52	33
	2003	65	13	20		
	2004	44	7	16		
	2005	100	7	7		
Kensington	1999	71	10	14		
2002/09/06	2000	40	2	5	70%	83%
	2001	100	4	4	23	16
	2002	100	5	5	29	24
	2003	60	3	5		
	2004	92	11	12		
	2005	71	5	7		
Ladismith HS	1999	100	5	5		
2002/05/14	2000	100	6	6		
	2001	75	3	4	92%	94%
	2002	100	3	3	13	12
	2003	100	11	11	31	29
	2004	90	9	10		
	2005	90	9	10		
Luckhoff	1999	0	0	3		
2002/05/27	2000	50	1	2	43%	45%
	2001	100	2	2	7	3
	2002	11	1	9	31	14
	2003	100	3	3		
	2004	0	0	7		3
	2005	83	10	12		14
Mondale	1999	50	4	8		
2002/06/27	2000	45	5	11	58%	84%
	2001	100	5	5	24	14
	2002	100	10	10	45	38
	2003	92	11	12		
	2004	60	9	15		
	2005	100	8	8		
New Orleans	1999	17	1	6		
2002/08/16	2000	50	2	4	36%	80%

	2001	100	1	1	11	4
	2002	100	4	4	10	8
	2003	60	3	5		
	2004	#DIV/0!	0	0		
	2005	100	1	1		
Oudtshoorn	1999	100	20	20		
2002/04/17	2000	96	23	24	96%	98%
	2001	93	27	29	73	70
	2002	100	28	28	121	118
	2003	97	33	34		
	2004	96	24	25		
	2005	97	33	34		
Pacaltsdorp	1999	15	2	13		
2002/09/19	2000	50	2	4	38%	86%
	2001	100	4	4	21	8
	2002	#DIV/0!	0	0	7	6
	2003	67	2	3		
	2004	100	3	3		
	2005	100	1	1		
Piketberg	1999	100	9	9		
2002/10/15	2000	89	8	9	96%	100%
	2001	100	10	10	28	27
	2002	100	9	9	34	34
	2003	100	13	13		
	2004	100	3	3		
	2005	100	9	9		
Proteus	1999	100	3	3		
20022/04/12	2000	38	3	8	47%	52%
	2001	38	3	8	19	9
	2002	63	5	8	27	14
	2003	63	5	8		
	2004	44	4	9		
	2005	0	0	2		
Rylands	1999	44	14	32		
2002/05/21	2000	95	20	21	70%	89%
	2001	81	22	27	80	56
	2002	87	20	23	107	95
	2003	82	23	28		
	2004	97	28	29		
	2005	89	24	27		
Schoonspruit	1999	100	13	13		
2002/05/03	2000	89	8	9	81%	70%
	2001	57	8	14	36	29
	2002	79	11	14	61	43
	2003	85	11	13		
	2004	52	13	25		

	2005	89	8	9		
Simon's Town	1999	50	3	6		
2002/10/07	2000	50	2	4	58%	72%
	2001	100	2	2	12	7
	2002	60	6	10	25	18
	2003	100	6	6		
	2004	67	2	3		
	2005	67	4	6		
Sinethemba	1999	33	2	6		
2002/03/15	2000	0	0	8	14%	34%
	2001	#DIV/0!	0	0	14	2
	2002	50	5	10	59	20
	2003	100	1	1		
	2004	63	5	8		
	2005	23	9	40		
Worcester	1999	20	1	5		
2002/08/22	2000	33	1	3	40%	53%
	2001	100	2	2	10	4
	2002	100	2	2	17	9
	2003	100	1	1		
	2004	33	2	6		
	2005	50	4	8		
Zwartberg	1999	100	3	3		
2002/09/18	2000	90	9	10	95%	91%
	2001	100	6	6	19	18
	2002	100	5	5	11	10
	2003	67	2	3		
	2004	100	2	2		
	2005	100	1	1		
TOTAL	1999	64	112	176		
	2000	71	118	167	72%	73%
	2001	83	128	155	498	358
	2002	75	173	232	1031	753
	2003	80	187	235		
	2004	68	194	286		
	2005	72	199	278		
PERCENTAGE	1999		64.20%			
	2000		70.66%			
	2001		82.58%			
	2002		74.57%			
	2003		80.00%			
	2003		68.18%			
	2005		71.94%			

Third Wave Higher Grade Pass rate for Pre-IT and Post-IT						
SCHOOL	**YEAR**	**% Passed**	**Passed**	**Enrolled**		
Belgravia	2000	62	8	13		
2003/02/10	2001	68	15	22	75%	80%
	2002	91	20	22	57	43
	2003	56	19	34	92	74
	2004	95	35	37		
	2005	95	20	21		
Bellville HTS	2000	100	37	37		
2003/11/14	2001	100	36	36	100%	97%
	2002	100	37	37	110	110
	2003	95	41	43	123	119
	2004	95	37	39		
	2005	100	41	41		
Bulumko	2000	0	0	0		
2003/05/22	2001	0	0	0	40%	39%
	2002	40	2	5	5	2
	2003	67	4	6	23	9
	2004	50	1	2		
	2005	27	4	15		
Cravenby	2000	100	10	10		
2003/02/20	2001	56	5	9	81%	76%
	2002	83	10	12	31	25
	2003	64	9	14	34	26
	2004	77	10	13		
	2005	100	7	7		
Gordon	2000	0	0	2		
2003/05/14	2001	0	0	0	29%	27%
	2002	40	2	5	7	2
	2003	29	2	7	33	9
	2004	7	1	15		
	2005	55	6	11		
Kwamfundo	2000	50	1	2		
2003/05/22	2001	0	0	0	50%	50%
	2002	0	0	0	2	1
	2003	40	2	5	22	11
	2004	33	1	3		
	2005	57	8	14		
Kylemore	2000	67	2	3		
2003/02/10	2001	100	1	1	75%	83%
	2002	0	0	0	4	3
	2003	100	4	4	12	10
	2004	60	3	5		
	2005	100	3	3		
Malibu	2000	88	7	8		

2003/10/29	2001	80	4	5	74%	58%
	2002	60	6	10	23	17
	2003	80	4	5	40	23
	2004	61	14	23		
	2005	42	5	12		
Norman Henshil.	2000	80	16	20		
2003/08/31	2001	70	14	20	79%	76%
	2002	86	18	21	61	48
	2003	100	14	14	45	34
	2004	88	14	16		
	2005	40	6	15		
Percy Madala	2000	0	0	0		
2003/08/07	2001	50	1	2	67%	75%
	2002	100	1	1	3	2
	2003	100	4	4	12	9
	2004	67	2	3		
	2005	60	3	5		
Sophumelela	2000	0	0	1		
	2001	0	0	0	33%	48%
	2002	50	1	2	3	1
	2003	100	1	1	29	14
	2004	50	7	14		
	2005	43	6	14		
Spine Road	2000	100	2	2		
	2001	40	2	5	67%	50%
	2002	75	6	8	15	10
	2003	100	4	4	22	11
	2004	55	6	11		
	2005	14	1	7		
TOTAL	2000	80	85	106		
	2001	74	84	113	78%	68%
	2002	80	109	136	355	278
	2003	76	116	152	597	404
	2004	67	152	228		
	2005	63	136	217		
PERCENTAGE	2000		80.19%			
	2001		74.34%			
	2002		80.15%			
	2003		76.32%			
	2004		66.67%			
	2005		62.67%			

APPENDIX V

KHANYA MATHEMATICS SG PROJECT: STAGE 2 DATA

First Wave Standard Grade Pass rate for Pre-IT and Post-IT				
SCHOOL	**YEAR**	**% Passed**	**Passed**	**Maths SG enrolment**
Bridgton	1999	66	35	53
2002/08/01	2000	54	27	50
	2001	86	30	35
	2002	81	42	52
	2003	72	34	47
	2004	95	39	41
	2005	60	28	47
Excelsior	1999	65	24	37
2002/08/01	2000	86	32	37
	2001	70	21	30
	2002	46	16	35
	2003	43	17	40
	2004	37	13	35
	2005	38	18	47
Garlandale	1999	44	73	165
2002/08/01	2000	61	85	139
	2001	49	75	153
	2002	64	96	151
	2003	50	89	178
	2004	45	61	136
	2005	56	69	123
Harold Cressy	1999	63	42	67
2002/08/01	2000	33	21	64
	2001	55	46	83
	2002	53	32	60
	2003	35	25	71
	2004	63	40	63
	2005	51	36	70
Klein	1999	61	47	77

Nederburg				
2002/08/01	2000	57	47	83
	2001	32	25	78
	2002	59	53	90
	2003	65	60	92
	2004	51	37	72
	2005	53	59	111
Livingstone	1999	84	114	135
2002/08/01	2000	80	127	159
	2001	76	71	94
	2002	76	78	102
	2003	76	86	113
	2004	73	80	109
	2005	87	82	94
Luhlaza	1999	58	42	73
2002/08/01	2000	66	61	93
	2001	53	49	92
	2002	85	92	108
	2003	81	58	72
	2004	88	83	94
	2005	68	62	91
Mandlenkosi	1999	44	8	18
2002/08/01	2000	42	13	31
	2001	59	16	27
	2002	61	11	18
	2003	57	8	14
	2004	64	9	14
	2005	55	12	22
Oscar Mpetha	1999	38	20	52
2002/08/01	2000	46	32	69
	2001	40	39	98
	2002	63	57	91
	2003	39	46	118
	2004	47	34	73
	2005	43	56	129
Sarepta	1999	59	47	79
2002/08/01	2000	56	60	108
	2001	48	51	107
	2002	61	74	122
	2003	70	68	97
	2004	84	77	92
	2005	62	54	87
South Penninsula	1999	57	62	108

2002/08/01	2000	66	93	140
	2001	53	80	150
	2002	72	84	116
	2003	90	111	124
	2004	86	82	95
	2005	92	78	85
TOTAL	1999	59	514	864
	2000	61	598	973
	2001	53	503	947
	2002	67	635	945
	2003	62	602	966
	2004	67	555	824
	2005	61	554	906
PERCENTAGE	1999		59.49%	
	2000		61.46%	
	2001		53.12%	
	2002		67.20%	
	2003		62.32%	
	2004		67.35%	
	2005		61.15%	

Second Wave Standard Grade Pass rate for Pre-IT and Post-IT

SCHOOL	YEAR	% Passed	Passed	Maths SG enrolment
Arcadia	1999	11	8	71
	2000	14	6	44
	2001	19	4	21
	2002	25	6	24
	2003	16	4	25
	2004	47	15	32
	2005	53	10	19
Athlone	1999	50	32	64
	2000	40	37	93
	2001	49	51	104
	2002	39	47	121
	2003	50	31	62
	2004	38	27	71
	2005	41	24	59
Atlantis	1999	62	18	29
	2000	50	20	40
	2001	59	27	46

	2002	67	37	55
	2003	75	44	59
	2004	75	39	52
	2005	73	29	40
Barrydale HS	1999	67	2	3
	2000	67	2	3
	2001	100	1	1
	2002	100	3	3
	2003	0	0	3
	2004	0	0	3
	2005	0	0	0
Bellville South	1999	31	9	29
	2000	35	8	23
	2001	21	13	63
	2002	48	13	27
	2003	27	12	44
	2004	10	3	29
	2005	60	12	20
Berg Rivier	1999	44	32	72
	2000	35	32	91
	2001	58	48	83
	2002	56	51	91
	2003	56	38	68
	2004	78	66	85
	2005	59	35	59
Bernadino Heights	1999	34	11	32
	2000	38	18	48
	2001	38	21	55
	2002	48	31	64
	2003	46	36	79
	2004	68	50	74
	2005	53	49	92
Blackheath	1999	30	14	47
	2000	69	35	51
	2001	38	15	39
	2002	67	37	55
	2003	42	33	79
	2004	49	28	57
	2005	69	33	48
COSAT	1999	0	0	0
	2000	0	0	0
	2001	100	8	8
	2002	100	9	9
	2003	100	9	9
	2004	100	17	17

	2005	92	12	13
Dysseldorp	1999	57	4	7
	2000	57	8	14
	2001	100	5	5
	2002	64	9	14
	2003	25	4	16
	2004	75	12	16
	2005	50	9	18
Emil Weder	1999	95	20	21
	2000	64	9	14
	2001	63	10	16
	2002	64	18	28
	2003	58	14	24
	2004	67	10	15
	2005	42	13	31
Grabouw	1999	80	8	10
	2000	100	8	8
	2001	100	14	14
	2002	100	3	3
	2003	100	6	6
	2004	86	6	7
	2005	100	6	6
Groenberg	1999	38	15	40
	2000	27	11	41
	2001	49	18	37
	2002	77	23	30
	2003	71	20	28
	2004	73	22	30
	2005	56	18	32
Groot-Brakrivier	1999	73	11	15
	2000	50	9	18
	2001	69	11	16
	2002	83	10	12
	2003	52	13	25
	2004	64	16	25
	2005	77	17	22
Hawston	1999	5	1	21
	2000	23	3	13
	2001	44	4	9
	2002	0	0	10
	2003	33	4	12
	2004	25	3	12
	2005	70	7	10
Houtbay	1999	21	7	33
	2000	19	4	21

	2001	33	3	9
	2002	27	6	22
	2003	48	10	21
	2004	43	13	30
	2005	55	12	22
Isilimela	1999	14	12	85
	2000	25	29	115
	2001	6	6	107
	2002	18	16	89
	2003	22	26	118
	2004	11	11	97
	2005	29	22	77
Kasselsvlei	1999	57	63	111
	2000	59	57	97
	2001	74	62	84
	2002	86	68	79
	2003	79	68	86
	2004	80	82	102
	2005	75	54	72
Kensington	1999	40	51	128
	2000	28	26	93
	2001	67	47	70
	2002	80	66	82
	2003	56	48	85
	2004	61	53	87
	2005	73	47	64
Ladismith HS	1999	82	9	11
	2000	100	7	7
	2001	100	7	7
	2002	100	9	9
	2003	89	8	9
	2004	93	14	15
	2005	82	14	17
Ladismith Sec	1999	29	4	14
	2000	42	5	12
	2001	71	5	7
	2002	100	9	9
	2003	100	5	5
	2004	70	7	10
	2005	88	14	16
Luckhoff	1999	25	7	28
	2000	36	8	22
	2001	48	14	29
	2002	86	25	29
	2003	49	20	41
	2004	39	15	38

	2005	57	30	53
Macassar	1999	19	6	31
	2000	41	11	27
	2001	14	3	22
	2002	34	13	38
	2003	26	8	31
	2004	24	8	34
	2005	20	5	25
Marian RC	1999	41	7	17
	2000	41	7	17
	2001	58	15	26
	2002	44	7	16
	2003	26	5	19
	2004	100	7	7
	2005	33	5	15
Mondale	1999	60	75	125
	2000	61	54	89
	2001	80	83	104
	2002	84	80	95
	2003	77	79	102
	2004	87	83	95
	2005	78	75	96
New Orleans	1999	75	44	59
	2000	64	30	47
	2001	33	26	79
	2002	62	38	61
	2003	56	32	57
	2004	61	44	72
	2005	37	33	89
Oudtshoorn	1999	93	53	57
	2000	98	50	51
	2001	92	35	38
	2002	93	37	40
	2003	84	43	51
	2004	96	53	55
	2005	95	36	38
Pacaltsdorp	1999	35	37	105
	2000	37	35	95
	2001	47	27	58
	2002	67	34	51
	2003	74	20	27
	2004	92	24	26
	2005	54	20	37
Perseverance	1999	2	2	98
	2000	32	7	22

	2001	33	7	21
	2002	46	12	26
	2003	39	9	23
	2004	52	12	23
	2005	29	8	28
Piketberg	1999	100	13	13
	2000	92	12	13
	2001	100	22	22
	2002	100	14	14
	2003	100	16	16
	2004	100	13	13
	2005	100	20	20
Proteus	1999	62	49	79
	2000	51	31	61
	2001	52	48	93
	2002	63	40	63
	2003	50	51	101
	2004	48	42	88
	2005	68	38	56
Qhayiya	1999	14	5	37
	2000	38	9	24
	2001	40	10	25
	2002	12	3	26
	2003	26	5	19
	2004	33	6	18
	2005	64	16	25
Rylands	1999	52	38	73
	2000	53	42	79
	2001	44	36	82
	2002	67	78	117
	2003	49	54	111
	2004	62	64	104
	2005	75	76	102
Schoonspruit	1999	73	38	52
	2000	92	33	36
	2001	83	38	46
	2002	70	35	50
	2003	89	62	70
	2004	85	63	74
	2005	93	62	67
Simon's Town	1999	90	18	20
	2000	82	28	34
	2001	74	23	31
	2002	59	17	29
	2003	83	24	29
	2004	78	18	23

	2005	56	22	39
Sinethemba	1999	36	19	53
	2000	14	16	113
	2001	41	25	61
	2002	48	52	109
	2003	60	53	88
	2004	79	49	62
	2005	31	22	70
Steenberg	1999	47	45	96
	2000	29	30	103
	2001	57	39	68
	2002	48	32	67
	2003	34	36	106
	2004	24	17	72
	2005	74	43	58
Symphony	1999	17	3	18
	2000	25	6	24
	2001	16	6	38
	2002	23	7	30
	2003	25	10	40
	2004	42	15	36
	2005	26	7	27
Westridge	1999	48	21	44
	2000	49	20	41
	2001	49	18	37
	2002	38	15	40
	2003	44	28	64
	2004	36	24	67
	2005	44	26	59
Wolseley	1999	80	4	5
	2000	43	6	14
	2001	50	9	18
	2002	88	15	17
	2003	63	10	16
	2004	92	11	12
	2005	93	14	15
Worcester	1999	67	12	18
	2000	53	17	32
	2001	69	11	16
	2002	80	12	15
	2003	90	19	21
	2004	71	27	38
	2005	57	16	28
Zwartberg	1999	71	5	7
	2000	80	4	5

	2001	86	6	7
	2002	50	1	2
	2003	71	5	7
	2004	100	5	5
	2005	100	4	4
TOTAL	1999	44	832	1878
	2000	44	790	1795
	2001	51	881	1722
	2002	59	1038	1771
	2003	54	1022	1902
	2004	60	1094	1828
	2005	60	1015	1688
PERCENTAGE	1999		44.30%	
	2000		44.01%	
	2001		51.16%	
	2002		58.61%	
	2003		53.73%	
	2004		59.85%	
	2005		60.13%	

Third Wave Standard Grade Pass rate for Pre-IT and Post-IT

SCHOOL	YEAR	% Passed	Passed	Maths SG enrolment
Belgravia	2000	59	57	96
	2001	53	56	106
	2002	71	79	112
	2003	60	83	139
	2004	75	82	110
	2005	68	90	133
Bellville HTS	2000	96	93	97
	2001	90	90	100
	2002	94	80	85
	2003	99	100	101
	2004	100	67	67
	2005	100	86	86
Bonteheuvel Sec	2000	19	6	31
	2001	17	4	24
	2002	22	4	18
	2003	27	6	22
	2004	30	6	20
	2005	22	4	18

Bulumko	2000	26	24	93
	2001	19	20	105
	2002	42	21	50
	2003	69	60	87
	2004	89	47	53
	2005	44	28	64
Cathkin	2000	62	13	21
	2001	57	17	30
	2002	91	21	23
	2003	95	21	22
	2004	94	15	16
	2005	71	10	14
Chris Hani	2000	19	30	160
	2001	43	33	77
	2002	44	53	120
	2003	74	40	54
	2004	48	28	58
	2005	80	24	30
Cravenby	2000	89	25	28
	2001	71	25	35
	2002	71	27	38
	2003	63	36	57
	2004	48	29	61
	2005	74	23	31
Crestway	2000	19	5	26
	2001	11	5	47
	2002	15	6	39
	2003	33	9	27
	2004	52	14	27
	2005	43	9	21
Gordon	2000	42	22	53
	2001	45	26	58
	2002	62	45	73
	2003	48	29	60
	2004	63	26	41
	2005	59	44	74
Grassy Park	2000	26	45	173
	2001	38	62	164
	2002	76	63	83
	2003	56	72	128
	2004	56	51	91
	2005	36	30	84
Indwe	2000	18	16	90
	2001	26	18	68
	2002	32	25	79

	2003	60	21	35
	2004	50	12	24
	2005	67	20	30
Kwamfundo	2000	27	25	92
	2001	23	28	121
	2002	35	44	124
	2003	29	40	138
	2004	37	55	149
	2005	23	37	159
Kylemore	2000	24	8	34
	2001	66	21	32
	2002	56	23	41
	2003	29	10	35
	2004	48	12	25
	2005	52	24	46
Lotus Sec	2000	4	1	25
	2001	13	2	15
	2002	53	8	15
	2003	71	15	21
	2004	45	14	31
	2005	56	10	18
Malibu	2000	32	49	155
	2001	39	44	113
	2002	58	53	92
	2003	73	58	80
	2004	73	72	98
	2005	53	50	95
Manzomthombo	2000	26	15	57
	2001	33	20	60
	2002	42	18	43
	2003	24	14	59
	2004	17	10	58
	2005	39	19	49
Masiyile	2000	30	23	76
	2001	18	14	78
	2002	22	17	79
	2003	44	35	80
	2004	50	41	82
	2005	33	39	119
Matthew Goniwe	2000	9	9	105
	2001	43	46	107
	2002	54	70	130
	2003	46	45	97
	2004	56	74	131
	2005	25	48	193

Modderdam	2000	30	13	43
	2001	41	11	27
	2002	30	12	40
	2003	44	15	34
	2004	34	13	38
	2005	30	10	33
Norman Henshil.	2000	77	44	57
	2001	84	59	70
	2002	74	57	77
	2003	77	58	75
	2004	80	56	70
	2005	70	39	56
Percy Madala	2000	24	12	50
	2001	65	20	31
	2002	24	12	50
	2003	78	21	27
	2004	76	19	25
	2005	59	13	22
Phoenix	2000	41	7	17
	2001	56	10	18
	2002	19	4	21
	2003	42	8	19
	2004	35	7	20
	2005	17	4	23
Ravensmead	2000	55	36	65
	2001	66	50	76
	2002	57	45	79
	2003	77	50	65
	2004	91	29	32
	2005	84	56	67
Saxonsea	2000	16	7	45
	2001	19	4	21
	2002	48	13	27
	2003	61	11	18
	2004	65	11	17
	2005	36	9	25
Sophumelela	2000	17	6	35
	2001	28	11	39
	2002	58	25	43
	2003	63	42	67
	2004	69	47	68
	2005	64	21	33
Spine Road	2000	51	37	72
	2001	59	38	64
	2002	51	37	72

	2003	76	38	50
	2004	46	24	52
	2005	43	17	40
St Andrews	2000	34	78	230
	2001	26	37	145
	2002	45	55	121
	2003	71	29	41
	2004	41	26	63
	2005	36	23	64
Strandfontein	2000	30	32	107
	2001	44	33	75
	2002	43	34	80
	2003	35	26	74
	2004	32	21	65
	2005	42	26	62
Valhalla	2000	73	19	26
	2001	54	7	13
	2002	35	12	34
	2003	61	25	41
	2004	86	12	14
	2005	16	4	25
Zandvliet	2000	26	8	31
	2001	33	8	24
	2002	76	26	34
	2003	60	18	30
	2004	64	23	36
	2005	53	26	49
TOTAL	2000	35	765	2190
	2001	42	819	1943
	2002	51	989	1922
	2003	58	1035	1783
	2004	57	943	1642
	2005	48	843	1763
PERCENTAGE	2000		34.93%	
	2001		42.15%	
	2002		51.46%	
	2003		58.05%	
	2004		57.43%	
	2005		47.82%	

Fourth Wave Standard Grade Pass rate for Pre-IT and Post-IT				
SCHOOL	YEAR	% Passed	Passed	Maths enrolled.
Belhar Sec	2001	47	45	95
	2002	39	48	123
	2003	55	56	102
	2004	49	56	114
	2005	57	79	139
Breërivier Sec	2001	23	8	35
	2002	85	23	27
	2003	82	32	39
	2004	64	28	44
	2005	46	26	56
Clanwilliam Sec	2001	50	11	22
	2002	67	14	21
	2003	52	12	23
	2004	76	19	25
	2005	54	7	13
Gerrit Du Plessis Sec	2001	48	15	31
	2002	70	32	46
	2003	83	34	41
	2004	58	25	43
	2005	53	17	32
Haarlem Sec	2001	36	5	14
	2002	67	12	18
	2003	35	7	20
	2004	26	5	19
	2005	40	8	20
Hector Pietersen Sec	2001	36	32	88
	2002	56	47	84
	2003	37	17	46
	2004	44	42	96
	2005	41	29	70
Hillcrest Sec	2001	31	11	36
	2002	42	14	33
	2003	53	10	19
	2004	84	21	25
	2005	68	17	25
Kairos	2001	50	4	8
	2002	35	6	17
	2003	0	0	13
	2004	60	9	15
	2005	25	4	16

Masakheke Combined	2001	50	4	8
	2002	100	8	8
	2003	100	15	15
	2004	100	7	7
	2005	67	6	9
Masibambane Sec	2001	16	13	83
	2002	16	9	57
	2003	18	11	62
	2004	40	27	68
	2005	51	39	77
Oval North Sec	2001	33	28	86
	2002	62	44	71
	2003	62	42	68
	2004	65	49	75
	2005	83	62	75
Pelican Park High School	2001	73	19	26
	2002	88	28	32
	2003	95	39	41
	2004	97	29	30
	2005	100	20	20
Phakama Sec	2001	13	7	56
	2002	28	23	82
	2003	24	14	58
	2004	27	22	81
	2005	35	28	79
Rocklands Sec	2001	68	48	71
	2002	72	50	69
	2003	80	59	74
	2004	73	43	59
	2005	48	35	73
Rusthof Sec	2001	15	2	13
	2002	6	1	17
	2003	25	4	16
	2004	31	5	16
	2005	18	4	22
Sao Bras Sec	2001	68	42	62
	2002	83	39	47
	2003	74	31	42
	2004	85	34	40
	2005	57	16	28
Scottsdene Sec	2001	17	4	23
	2002	33	10	30
	2003	50	9	18
	2004	17	4	24

	2005	40	10	25
Swartberg	2001	50	8	16
	2002	100	12	12
	2003	79	11	14
	2004	85	11	13
	2005	33	5	15
Thandokhulu High	2001	83	20	24
	2002	86	24	28
	2003	88	42	48
	2004	79	37	47
	2005	67	28	42
Thembilhele Sec	2001	13	9	72
	2002	69	20	29
	2003	39	14	36
	2004	30	29	96
	2005	22	17	76
Uitzig Sec	2001	37	7	19
	2002	45	5	11
	2003	10	1	10
	2004	0	0	0
	2005	0	0	0
Zola Senior Sec	2001	17	7	41
	2002	83	10	12
	2003	79	38	48
	2004	56	20	36
	2005	68	26	38
TOTAL	2001	38	349	929
	2002	55	479	874
	2003	58	498	853
	2004	54	522	973
	2005	51	483	950
PERCENTAGE				
	2001		37.57%	
	2002		54.81%	
	2003		58.38%	
	2004		53.65%	
	2005		50.84%	

APPENDIX VI

STAGE 3: SOCIO-ECONOMIC STATUS

NO.	SCHOOL NAME	POVERTY	QUINTILE
1	ARCADIA SEN. SEK.	.626480698	3rd Poorest
2	ATHLONE SEC.	.530224280	4th Poorest
3	ATLANTIS SEK.	.542615719	4th Poorest
4	BARRYDALE HS.	.755546730	2nd Poorest
5	BELGRAVIA SEC.	.447804861	4th Poorest
6	BELLVILLE HTS.	.122692650	Least Poorest
7	BELLVILLE-SUID SEK.	.620303250	3rd Poorest
8	BERGRIVIER SEK.	.619525512	3rd Poorest
9	BERNADINO HEIGHTS SEK.	.402455617	Least Poorest
10	BLACKHEATH SEK.	.520530749	4th Poorest
11	BONTEHEUWEL SEK.	.637751010	3rd Poorest
12	BREëRIVIER HS.	.765048266	2nd Poorest
13	BRIDGTON SEK.	.696670510	2nd Poorest
14	BULUMKO SEC	.766668948	2nd Poorest
15	CATHKIN SEC.	.673001976	3rd Poorest
16	CHRIS HANI SEC	.795770967	1st Poorest
17	CRAVENBY SEC	.488797697	4th Poorest
18	CRESTWAY SEC.	.615933915	3rd Poorest
19	DYSSELSDORP SEK.	.830263568	1st Poorest
20	EMIL WEDER SEK.	.747984016	2nd Poorest
21	ESANGWENI SEC.	.783911695	2nd Poorest
22	EXCELSIOR SEK.	.615024895	3rd Poorest
23	GARLANDALE SEK.	.379440129	Least Poorest
24	GORDON SEK.	.368770523	Least Poorest
25	GRABOUW HS.	.363286281	Least Poorest
26	GRASSY PARK SEC.	.490006773	4th Poorest
27	GROENBERG SEK.	.608558266	3rd Poorest
28	GROOT-BRAKRIVIER SEK.	.711978410	2nd Poorest
29	HAROLD CRESSY HS.	.418155444	Least Poorest
30	HAWSTON SEK.	.666309716	3rd Poorest
31	HILLCREST SEK.	.651446948	3rd Poorest

32	HOUTBAAI SEK.	.741421555	2nd Poorest
33	INDWE SEC	.825834458	1st Poorest
34	ISILIMELA SEC	.710783333	2nd Poorest
35	KASSELSVLEI KOMPREHENSIEWE HS	.603305023	3rd Poorest
36	KENSINGTON SEC.	.396060038	Least Poorest
37	KLEIN NEDERBURG SEK.	.573850857	4th Poorest
38	KWAMFUNDO SEC.	.789989514	1st Poorest
39	KYLEMORE SEK.	.796274360	1st Poorest
40	LADISMITH HS.	.387784387	Least Poorest
41	LADISMITH SEK.	.628043222	3rd Poorest
42	LIVINGSTONE HS.	.383353196	Least Poorest
43	LOTUS SEK.	.557401753	4th Poorest
44	LUCKHOFF SEK.	.512326549	4th Poorest
45	LUHLAZA SEC	.774047975	2nd Poorest
46	MACASSAR SEK	.574172024	4th Poorest
47	MALIBU SEK.	.525689241	4th Poorest
48	MANDLENKOSI SEC	.724157023	2nd Poorest
49	MANZOMTHOMBO SEC.	.749787841	2nd Poorest
50	MARIAN RC SEC.	.659400683	3rd Poorest
51	MASAKHEKE COMBINED	.801252928	1st Poorest
52	MASIBAMBISANE SEC.	.536293065	4th Poorest
53	MASIYILE SENIOR SEC	.778261237	2nd Poorest
54	MATTHEW GONIWE MEMORIAL HS.	.804701729	1st Poorest
55	MODDERDAM SEK.	.643478926	3rd Poorest
56	MONDALE HS.	.498523297	4th Poorest
57	NEW ORLEANS SEK.	.730827425	2nd Poorest
58	NORMAN HENSHILWOOD HS.	.208062061	Least Poorest
59	OSCAR MPETHA HS	.795382531	1st Poorest
60	OUDTSHOORN HS.	.274013763	Least Poorest
61	OVAL NORTH SEC.	.628330413	3rd Poorest
62	PACALTSDORP SEK.	.662945056	3rd Poorest
63	PELICAN PARK HIGH SCHOOL	.544321874	4th Poorest
64	PERCY MDALA HS.	.824363373	1st Poorest
65	PERSEVERANCE SEK	.655422125	3rd Poorest
66	PHOENIX SEK.	.674981816	3rd Poorest
67	PIKETBERG HS.	.326617683	Least Poorest
68	PROTEUS SEK.	.554840167	4th Poorest
69	QHAYIYA SEC. SCHOOL	.904501563	1st Poorest
70	RAVENSMEAD SEK.	.621146995	3rd Poorest
71	RYLANDS HS.	.386053751	Least Poorest
72	SAREPTA SEK.	.365446561	Least Poorest

73	SAXONSEA SEK.	.629843644	3rd Poorest
74	SCHOONSPRUIT SEK.	.602468353	3rd Poorest
75	SIMON'S TOWN SCHOOL	.291512973	Least Poorest
76	SINETHEMBA SEC.	.805050093	1st Poorest
77	SOPHUMELELA SEC	.703148698	2nd Poorest
78	SOUTH PENINSULA HS.	.311116612	Least Poorest
79	SPINE ROAD SEC.	.562139351	4th Poorest
80	ST. ANDREW'S SEK.	.683647009	3rd Poorest
81	STEENBERG SEC.	.549999870	4th Poorest
82	STRANDFONTEIN SEK.	.552118791	4th Poorest
83	SYMPHONY SEK.	.603754583	3rd Poorest
84	VALHALLA SEK	.652301343	3rd Poorest
85	WESTRIDGE SEC.	.484518333	4th Poorest
86	WOLSELEY SEK.	.505103876	4th Poorest
87	WORCESTER SEK.	.800836832	1st Poorest
88	ZANDVLIET HS.	.557160114	4th Poorest
89	ZOLA SENIOR SEC	.564313713	4th Poorest
90	ZWARTBERG HS.	.482204258	4th Poorest